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THE PRIMARY POINT OF INFECTION IN TUBERCULOSIS OF THE HIP JOINT

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TUBERCULOSIS of the skeleton practically always arises as a result of hematogenous spread of the disease from primary foci in other regions. In children, the primary tuberculous infection is usually in the lung and the tracheobronchial lymph nodes but sometimes the primary site is in the intestine and mesenteric lymph nodes or elsewhere. In adults, skeletal tuberculosis may in some patients develop by hematogenous spread of bacilli from an old primary complex of childhood, but more often there is evidence of an active or arrested adult type of pulmonary lesion. In this clinic, for example, 36 patients with skeletal tuberculosis which started in adult life showed roentgen evidence of active pulmonary tuberculosis in 14, probably inactive fibrotic or calcified lung lesions in 9, calcified primary infections in 6, and no evidence of pulmonary tuberculous infection in 7. A joint in a relatively small percentage of cases becomes secondarily involved by extension from tuberculosis of surrounding structures such as bursæ, tendon sheaths, and other joints. Tuberculous bursitis about the hip, the knee, and in the hand has been known to involve the adjacent joints and tenosynovitis of the hand and foot has extended to the neighboring joints. Tuberculosis of the tarsal and carpal joints frequently spreads to other neighboring joints as, for example, subastragalar tuberculosis which involves the ankle by direct extension or tuberculosis of the proximal tibiofibular joint which gives rise to infection of the knee. In the great majority of cases, however, the joint becomes involved by organisms that localize from the blood stream either in the synovia or in the neighboring bone. The location of the primary point of involvement of the joint structure is variable. When the primary focus is in the bone, it may be either in the epiphysis or in the diaphysis. There exists as yet no accurate estimate of the relative frequency with which the synovia, epiphysis, and diaphysis are primarily involved and there is variation in relative frequency of primary involvement of the various joint structures according to age and the joint under consideration.

This study is concerned with the primary point of involvement of the hip joint in tuberculosis beginning in both childhood and adult life. Either the synovia or the innominate bone or the upper end of the femur including the capital and trochanteric epiphyses and their metaphyses may be the primary site. A few instances in which tuberculosis of the gluteal and iliopsoas bursæ has spread to involve the hip joint have been reported. Evidence as to the primary site of the joint disease may be obtained by means of roentgenological and

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pathological examinations. The great advantage of the roentgen-ray is that it can be employed early in the disease at which time it may disclose the primary focus, if osseous, and subsequent examinations may show the extension to other structures of the joint. Pathological examination on the other hand may disclose primary synovial involvement or small osseous foci which are not recognizable in roentgenograms. As the disease advances and bone destruction progresses, it usually becomes increasingly more difficult from a single roentgenological or a pathological examination to determine accurately the primary point of involvement of the joint structure. Extensive bone destruction about the joint may be due either to increase in size of the primary bone focus or to secondary involvement by extension from the tuberculous arthritis. In advanced cases it is often impossible to determine the primary point of infection. It is sometimes true that a greater extent of involvement of the bone on one side of the joint results from primary localization in that bone, but more frequently extensive bone destruction is the result of secondary invasion from the joint.

The material studied in this report comprises 82 case reports of patients who suffered from tuberculosis of the hip. In 70 of them the disease began in childhood and in 12 it began in adult life. The studies were made at extremely variable times after the onset of the disease and extended over variable periods of time in each case. This made a great deal of individual difference in the accuracy with which the primary point of infection could be determined. Also it should be borne in mind that the treatment varied considerably in the individual cases, which accounts for some of the variations in the pathological and roentgenological pictures obtained.

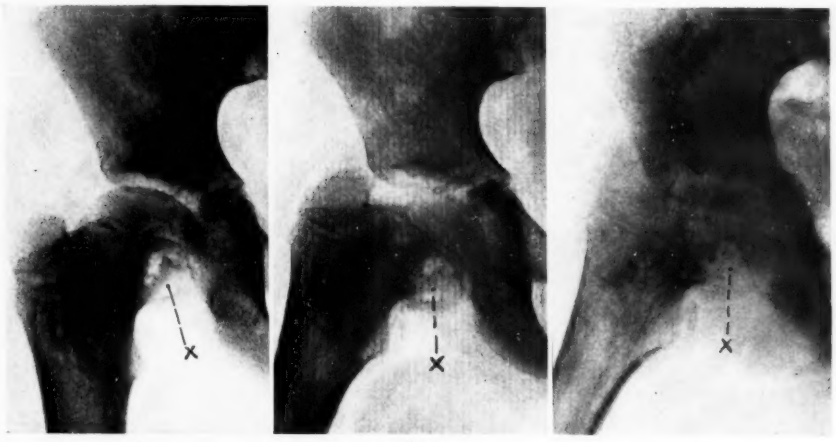
PRIMARY POINT OF INFECTION OF HIP JOINT IN CHILDHOOD

Primary osseous lesions of tuberculosis were more often seen about the hip in children than in adults. The reason for this is probably that during growth, the bones about the joint receive a proportionately larger blood supply than is the case after growth has ceased. Another factor is the existence of end arteries in the metaphyses, as has been demonstrated by Nussbaum (2). From the standpoint of primary localization, the 70 cases of hip joint tuberculosis which occurred in childhood are grouped as follows:

Location	No. of cases
Neck of femur	14
Ilium	10
Ischium	2
Capital femoral epiphysis	0
Uncertain	44

Primary focus in the femur. The juxta-epiphyseal region of the neck of the femur was the most common site of primary osseous involvement in the series. Many of the lesions broke into the joint early but others apparently remained localized in the femoral neck for a relatively long time. Sometimes sufficient growth took place at the capital epiphyseal cartilage to bring the focus into the distal portion of the neck or the intertrochanteric region. Seven of the 14 patients were seen before there was definite clinical or roentgenological evidence of joint change. Repeated roentgenograms over a period of time, however, showed definite changes in the articular surfaces in all except 2 of the patients. The following case reports illustrate the primary focus in the neck with secondary arthritis.

CASE 1. D. M., female, aged 7 years, had pain in the hip for 6 months and on examination had very slight limitation of motion. Figure 1, a, shows an area of rarefaction in the inferior juxta-epiphyseal region of the neck. The inferior cortex of the neck is eroded and a slight shadow of superficial new bone is present. The shadows of the bony articular cortices of the head and acetabulum are intact and the cartilage space of the joint is of normal width. Immobilization of the extremity in a plaster hip spica cast with bed rest and a general anti-tuberculous regimen were carried out. There was improvement in the patient's general physical condition, and a roentgenogram (Fig. 1, b) taken 4 months after entry shows signs of healing of the primary osseous lesion. After 7 months, however, the child was losing weight and there were daily temperature rises to 38 to 38.5 degrees C. The roentgenogram which was taken at this time (Fig. 1, c) shows definite spread throughout the joint as evidenced by the loss of shadows of the bony articular cortices of the femoral head and acetabulum. Marked atrophy of the bone almost obscures the primary metaphyseal lesion. At operation a tuberculous synovitis was found. The articular cartilages were extensively eroded and loosened from the underlying bone. In the inferior region of



a b c

Fig. 1. Case 1. Primary focus of tuberculosis in the neck of the femur: a, taken 6 months after onset, shows an area of reduced density, *x*, in the inferior juxta-epiphyseal region of the femoral neck—the shadows of the bony articular cortices and the articular cartilage space are normal; b, taken 4 months later, shows evidence of slight healing of the osseous focus with still no evidence of joint destruction; c, taken after 7 months, shows marked regional atrophy, loss of the shadows of the bony articular cortices, and a narrowed articular cartilage space; the primary neck focus is indistinct because of marked atrophy.

the neck there was a cavity 1 centimeter in diameter which extended through the epiphyseal cartilage and into the capital epiphysis. Excision of the articular cartilages of the hip joint, curettage of the focus in the neck, and arthrodesis by full thickness tibial bone transplants were done. A sinus followed operation; the transplants had to be removed and 1 year later there was still no bony ankylosis but also no further spread of the disease.

Case 2. A. K., male, aged 7 years, had pain and limp in the right hip for 2 years. The hip joint was freely movable. Figure 2, a, shows a large area of reduced density in the mesial portion of the neck. The cartilage space and the shadows of the bony

a b c d

Fig. 2. Case 2. Tuberculosis of the hip primary in the neck of the femur: a, shows area of reduced density, *x*, in the mesial portion of the metaphysis, a slight shadow of overlying periosteal bone, intact shadows of the bony articular cortices, and the normal cartilage space of the joint; b, taken 11 months after curettage, shows bony repair of the osseous focus; c, taken 2 years after operation, shows further healing of the primary focus but there are narrowed articular cartilage space, an irregular loss of the shadows of the bony articular cortices, and a lateral erosion of the capital epiphysis which indicates tuberculous arthritis; d, taken 8 months later, shows slight flattening of the capital epiphysis and slight sclerosis about its lateral area of erosion.

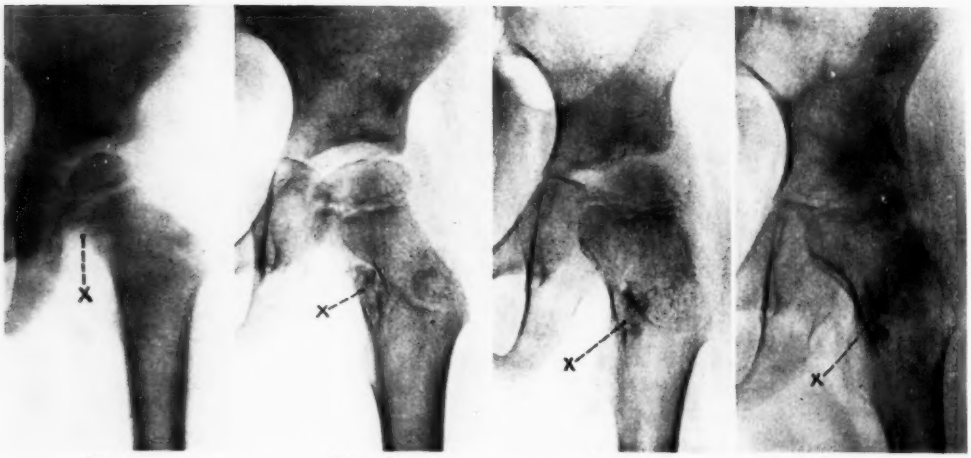


Fig. 3, a. Fig. 3, b. Fig. 3, c. Fig. 3, d.

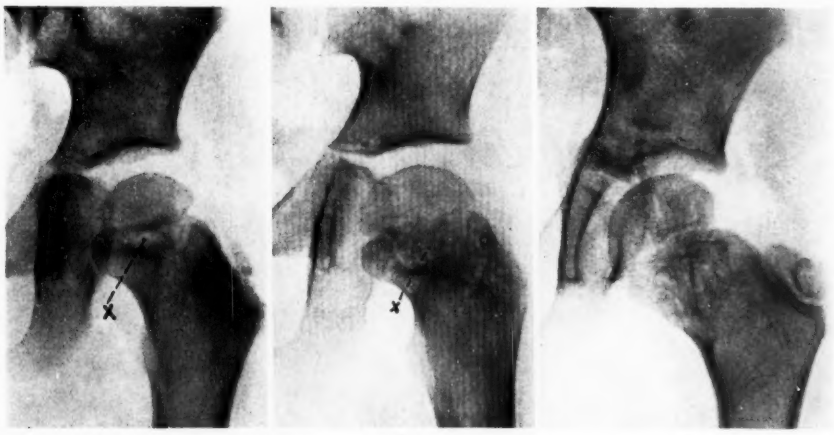
Fig. 3. Case 3. Tuberculosis of the hip primary in the femoral metaphysis: a, taken 6 months after onset, shows a triangular area of reduced density, *x*, mesially in the neck, a normal cartilage space of the joint, and normal shadows of the bony articular cortices; b, taken 1½ years later, shows displacement of the primary metaphyseal focus to the mesial portion base of the neck and flattened capital epiphysis; c, taken 7 months later, shows loss of the shadows of the bony articular cortices and narrowed articular cartilage space which indicate tuberculous arthritis; d, taken 5 months later, shows loss of the bony shadow of the capital epiphysis and ilium over the superior portion of the joint.

Fig. 4.

Fig. 4. Case 3. Photomicrograph showing necrotic articular cartilage, *a*, undermined and invaded by subchondral non-specific granulation tissue, *b*, which has absorbed the bony articular cortex and the subchondral cancellous bone (×37).

articular cortices show no change. Because of the absence of definite evidence of general involvement of the joint, operation to eradicate the primary bone lesion was done. The neck focus was tunnelled into laterally from beneath the greater trochanter and tuberculous granulation tissue was curetted out without opening into the joint. A plaster dressing has now been worn for 3 years and 4 months since operation. Figure 2, b, taken 11 months after operation shows repair of the neck lesion and still no signs of general joint destruction. However, at 18 months there was some irregular destruction of the bony articular cortices and narrowing of the articular cartilage space indicative of a spread into the joint. A roentgenogram taken 2 years after operation (Fig. 2, c) shows further narrowing of the cartilage space and erosion of the lateral non-contacted portion of the head of femur. Two years and 8 months after operation (Fig. 2, d) there is evidence of slight flattening of the head and sclerosis of the margins of the destructive areas on its lateral and mesial portions. Despite fairly early surgical eradication of the neck focus the hip joint later showed signs of progressive involvement by the tuberculous process.

Case 3. J. G., aged 4 years, had pain and limp in the left hip for 2 years. Examination showed marked muscle spasm. Figure 3, a, taken 6 months after

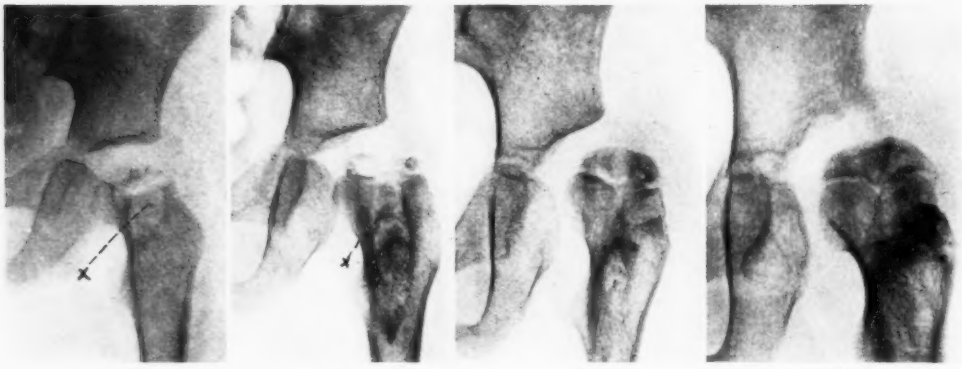


a b c

Fig. 5. Case 4. Primary osseous focus in the femoral neck: a, shows a central juxta-epiphyseal region of reduced density, *x*, but no evidence of joint involvement; b, taken after 17 months, shows distal extension of the primary focus in the neck; c, taken after 3½ years, shows an almost healed neck lesion and an intact joint.

onset shows a triangular area of reduced density in the mesial one-third of the femoral neck with its base bordering on the epiphyseal line. The cartilage space of the joint is of normal width and the shadows of the articular cortices are intact. A roentgenogram taken on admission (Fig. 3, b) 1½ years later shows continued growth of the femoral neck with displacement of the focus to the mesial portion of its base and blotchy increase in the density of the focus indicative of bony repair. The head shows signs of flattening but there is little if any narrowing of the cartilage space or reduced density of the articular cortical shadows. Biopsy of the synovia showed tuberculosis by microscopic and guinea pig tests. Treatment consisted of plaster encasement for 11 months and 3 weeks despite which there was progressive destruction of the joint. The sclerosed area of primary involvement in the neck had been further displaced distally. Figure 3, c, shows the loss of the shadow of the articular cortices and narrowing of the cartilage space after 7 months, and Figure 3, d, shows the loss of bone in the head and ilium along the upper portion of the joint 5 months later. Operation was then performed. There was extensive tuberculous synovitis. The head was flattened and reduced in size and its articular cartilage was largely intact but loosened. The joint was resected, including the small head and underlying epiphyseal cartilage disc, and whole thickness tibial bone transplants were introduced. A microscopic section (Fig. 4) of the head shows the articular cartilage to be necrotic and undermined by granulations consisting of round cells, fibroblasts, and some necrotic débris, but containing no tubercles. The bone in the epiphysis had been extensively worn down from the surface but the remaining deeper portion to the epiphyseal cartilage disc was alive and showed no sign of tuberculous invasion.

In regions other than the hip, healing of a metaphyseal or diaphyseal focus of tuberculosis without joint involvement is observed occasionally. Foci in the distal femoral and the tibial metaphyses have been observed to heal spontaneously or after surgical eradication, leaving the neighboring joints uninvolved. In spina ventosa, the adjacent joints are rarely involved and healing is usual. At the hip, however, metaphyseal lesions which are large enough to be recognizable in roentgenograms usually spread to the joint. Approximately two-thirds of the femoral neck is separated from the joint by only the thin covering of periosteum and reflected capsule so that infection in the neck can readily gain access to the joint. The common marginal localization of the primary focus in the metaphysis also favors extension into the joint. In 2 patients the central location of the lesion, which healed without progressive joint involvement, was probably of importance in the sparing of the joint. Spontaneous extracapsular drainage of the tuberculous abscess in 1 patient was also probably a factor in keeping



a b c d

Fig. 6. Case 5. Primary osseous tuberculosis of the neck of the femur with sparing of the joint: a, shows a central area of rarefaction, *x*, in the neck, a flattened and irregular capital epiphysis of greater density centrally than peripherally, and a shadow of slight periosteal bone formation laterally on the femoral shaft; b, taken 20 months later, shows distal extension of the metaphyseal focus and loss of the bony shadow centrally in the femoral head; c, taken after 3½ years, shows evidence of marked healing. The capital epiphysis is flattened but is more regular in contour, and there is partial lateral dislocation; d, taken 7 years after the onset of symptoms, shows a flattened capital epiphysis of uniform density and bony repair of the primary neck focus.

the joint free of tuberculosis. In the following case a central juxta-epiphyseal lesion of the femoral neck healed without evidence of arthritis.

CASE 4. R. L., male, aged 5 years, had pain in the left hip for 9 months associated with night cries. Examination showed unrestricted motion at the hip. A skin tuberculin test was positive to 1:1000 old tuberculin. Figure 5, a, shows a central juxta-epiphyseal area of reduced density in the neck metaphysis. The articular cartilage space is undiminished and the epiphysis is of normal contour and density. Treatment consisted of immobilization in plaster dressings for 2 years. A roentgenogram taken after 17 months (Fig. 5, b) shows some distal extension of the focus in the neck but there is no evidence of general involvement of the joint. Three and one-half years after the first examination there were no symptoms and free motion was present at the hip. Figure 5, c, shows the intact joint and slightly widened femoral neck with small areas of rarefaction which represent the almost healed focus which has become displaced downward in the neck by growth from the capital epiphyseal disc.

Since there was no tissue examination in this case the diagnosis of tuberculosis was not proved. The symptoms, positive tuberculin test, and roentgenographic characteristics of the lesion, however, make a diagnosis of tuberculosis by far most likely.

The following case is one of proved metaphyseal tuberculosis in which roentgenograms taken over a period of 7 years showed no progressive destruction of the joint, and biopsy showed no tuberculous synovitis. Epiphyseal changes were present and were indicative of either extension of the tuberculous infection to its bony center or possibly interference with the blood supply followed by necrosis with subsequent regeneration.

CASE 5. T. C., female, aged 2 years, had pain in the left hip for 4 months. Examination showed tenderness about the hip but motion was only slightly restricted. Aspiration of the joint yielded no fluid. Figure 6, a, shows a large central area of reduced density in the femoral metaphysis which borders on the epiphyseal cartilage and extends down the neck to the intertrochanteric region. The bony center of the capital epiphysis is irregular and flattened and of greater density centrally than peripherally. The cartilage space of the joint is of normal width. A shadow of slight periosteal bone formation is present on the lateral aspect of the femoral shaft. A diagnosis of tuberculous focus in the femoral metaphysis with secondary involvement of the bony center of the head was made and plaster immobilization of the hip joint was carried out for 7 years. After 6 months a cold abscess was found to be present anteriorly in the thigh and this spontaneously opened just above the knee. Guinea pig inoculation showed tuberculosis, and granulations from the sinus were microscopically tuberculous. A roentgenogram (Fig. 6, b) taken after 20 months shows extension downward of the metaphyseal lesion to the lower level of the lesser trochanter and extensive loss of the bony shadow in the femoral head. There is no narrowing of the cartilage space of the joint and the cortex of the acetabulum shows no change. There is slight lateral displacement of the head of the femur. Another roentgenogram (Fig. 6, c) taken 3½ years after the

a b c

Fig. 7. Case 6. Tuberculosis of the hip primary in the neck of the femur: a, shows a diffuse area of rarefaction, *x*, in the metaphysis which contains smaller shadows of bone of greater density than the surrounding atrophic bone, a slight loss of the shadow of the bony articular cortex at the lateral margin of the femoral head but an undiminished cartilage space of the joint; b, taken 1 year later, shows non-union of the tibial transplants to the femur and partial healing of the neck focus; c, taken 2 years after the second transplant was done, shows solid fusion of the joint and healing of the neck focus.

first examination shows evidence of marked healing of the metaphyseal focus. The bony center of the epiphysis is flattened but is more regular in contour and the central area of rarefaction is decreased in size in comparison with the previous roentgenogram. The hip is partially dislocated but there is no roentgen evidence of progressive tuberculous involvement of the joint. Biopsy of the hip joint was then performed. The articular cartilages were grossly normal. Microscopically the synovia showed no evidence of tuberculosis and guinea pig inoculation was negative. Seven years after the onset of symptoms the hip

a b c

Fig. 8. Case 7. Tuberculosis of the hip primary in the neck of the femur: a, shows area of bone absorption, *x*, in the inferior region of the neck surrounding the sequestrum, erosion of the inferior cortex of the neck, an articular cartilage space of normal width, a capital epiphysis that is atrophic but is of normal contour, the presence of lamellar shadows of periosteal new bone laterally on the diaphysis; b, taken 1 year later, shows sclerosis of the margins of the primary focus, a diminution in the size of the sequestrum, but a narrowed articular cartilage space and indistinct shadows of the bony articular cortices which indicate joint invasion; c, taken after 2 years, shows invasion and destruction of the opposing regions of the ilium, capital epiphysis, and metaphysis.

Fig. 9, a.

Fig. 9, b.

Fig. 9, c.

Fig. 9, d.

Fig. 9, e.

Fig. 9, f.

Fig. 9, g.

Fig. 10.

Fig. 9. Case 8. Tuberculosis of the hip primary in the ilium: a, shows area of reduced density, *x*, in the ilium near the joint and Y-cartilage of the acetabulum, normal articular surfaces; b, taken 1 year later, shows the increased size of the osseous focus, destruction of the neighboring bony articular cortex of the acetabulum, and a slightly flattened capital epiphysis; c, taken after 3 years, shows marginal sclerosis about the enlarged bony lesion; d, taken after 6 years, shows a large area of reduced density in the ilium with smaller flecks of greater density within it. There is a shadow of intact bony articular cortex over the lateral one-third of acetabulum and over the slightly flattened femoral head but loss of it over the involved region of the acetabulum. e, Taken 11 months after eradication of the primary focus in the ilium, shows filling in by bone and no additional evidence of joint destruction; f, taken 4 months later, shows further narrowing of the articular cartilage space and lateral and mesial erosion of the capital epiphysis which indicates active tuberculous arthritis; g, taken 4 months after operation, shows union of the bone transplants with ankylosis.

Fig. 10. Case 8. Photograph of resected articular surface of the head of the femur showing relatively well preserved articular cartilage, *a*, over the superior portion.

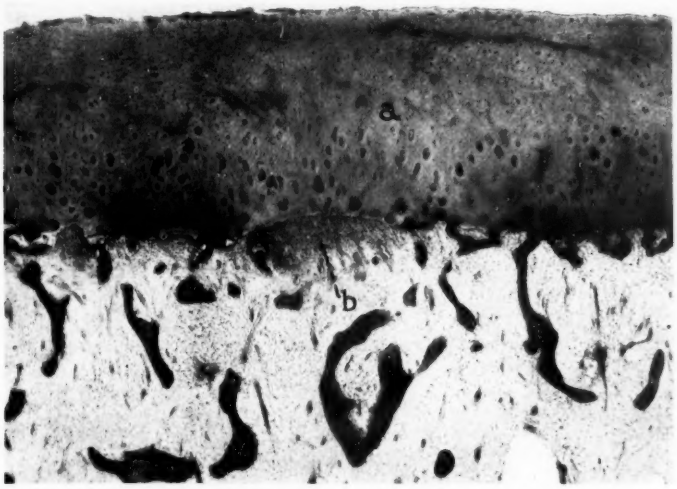


Fig. 11. Case 8. Photomicrograph of the lateral region of the superior articular surface of the femoral head showing necrotic cartilage, *a*, partly separated from the underlying bone by subchondral granulation tissue, *b*, which has largely destroyed the bony articular cortex (×225).

joint was freely movable. Knee flexion was markedly limited due to scarring of the quadriceps muscle about the healed sinuses. The roentgenogram (Fig. 6, d) taken then shows complete replacement of the flattened capital epiphysis by bone of uniform density and bony repair of the primary neck lesion without evidence of joint destruction.

The character of the metaphyseal lesions varied in the different cases and at different stages of the disease. In 10 cases of Group I, the primary lesion was located in the inferior juxta-epiphyseal region as illustrated in Cases 1, 2, and 3, and appeared in the roentgenograms as a local area of reduced density, sometimes with smaller shadows of relatively greater density which represented small sequestra. In the following case the neck lesion was more diffuse and evidence of general involvement of joint structure appeared early.

Case 6. B. C., male, aged 11 years, had slight pain in the right hip for 5 months. On examination it was found that motion of the hip was restricted to about half of the normal range. Figure 7, a, shows diffuse rarefaction in the metaphysis within which appear smaller shadows of greater density than the surrounding atrophic bone. There is also slight marginal loss of the shadow of the bony articular cortex of the femoral head but the cartilage space is undiminished.

At operation curettement of the metaphyseal lesion and arthrodesis of the hip with tibial bone grafts were done. Tuberculous synovitis was found to be present. Openings in the superior cortex of the femoral neck led to the bony focus from which tuberculous granulation tissue and many small bone sequestra were curetted. Microscopic examination of the articular cartilage at the lateral margin of the femoral head showed it to be undermined and its bony articular cortex broken down by non-tuberculous granulations. Roentgenograms taken 1 year later (Fig. 7, b) show non-union of the tibial grafts to the femur. A portion of the primary focus is still evident in the femoral neck. A second operation was done, at which time the articular cartilages were excised and massive tibial grafts were placed across the joint. Bony fusion was present 4 months later. A roentgenogram (Fig. 7, c) made 23 months after the second operation shows solid fusion of the joint and healing of the metaphyseal focus.

In another case, severe tuberculous infection of the metaphysis resulted in a large bony sequestrum which underwent slow and incomplete absorption over a period of 2 years. A large tuberculous abscess formed early in the disease and regional diaphyseal periosteal bone formed early but disappeared with subsidence of active infection. Healing of local bony lesion evidenced by development of marginal sclerosis and by some filling in by bone.

CASE 7. R. R., Mexican male, aged 2 years and 6 months, had pain in the left hip for 4 months and swelling of the upper thigh for 2 weeks. Examination showed marked muscle spasm at the left hip and a fluctuant mass located laterally in the upper part of the thigh. A skin tuberculin test was positive 1:10,000 old tuberculin. Figure 8, a, shows an area of bone absorption in the inferior portion of the femoral neck surrounding a large separated bony fragment which is of greater density than the adjacent living bone. The inferior cortex of the femoral neck is destroyed. The articular cartilage space is of normal width and the bony center of the capital epiphysis is reduced in density but has its normal contour. Lamellar shadows of periosteal new bone are present along the lateral aspect of the proximal half of the diaphysis. A diagnosis of metaphyseal tuberculosis with secondary arthritis was made and treatment by immobilization of the hip, bed rest, and general antituberculous care was carried out. A roentgenogram (Fig. 8, b) taken 1 year after the first examination, shows some sclerosis of the bone about the large metaphyseal focus and diminution in the size of the sequestrum. The articular cartilage space is slightly narrowed and the shadows of the articular cortices are indistinct. The shadow of periosteal new bone along the diaphysis which was present at the first examination is no longer seen. Although the child's physical condition improved, the roentgenogram taken 1 year later (Fig. 8, c) shows invasion and destruction of opposing regions of the ilium, capital epiphysis, and metaphysis. The primary osseous focus in the inferior portion of the neck shows evidence of healing. The sequestrum in the center of the focus is very small.

Primary focus in the ilium. In childhood the articular cartilages of the acetabulum and the Y-shaped cartilage contribute by enchondral bone formation to the growth of the innominate bone. In regions of active enchondral ossification there is a relatively abundant vascular supply so that lodgment of infected emboli from the circulation is favored. In 10 child patients with tuberculosis of the hip, the primary focus was identified in the ilium bordering on the acetabulum. In 3 of these the early roentgenograms showed the presence of the osseous focus before showing evidence of general involvement of the joint. One of them, a 7 year old male, known to have been heavily exposed to tuberculous infection, was recently observed 1 week after the onset of pain about the hip. Roentgen examination at that time disclosed no definite evidence of a bone lesion. A roentgenogram taken 2 weeks later, however, showed an area of reduced density in the ilium bordering on the acetabulum and the Y-shaped cartilage with a shadow of regional periosteal new bone on the mesial surface of the ilium but no evidence of arthritis. Thorough curettage of this focus without entering the hip joint has been followed by subsidence of symptoms and at this time, 16 months after the operation, there is no evidence of hip joint involvement. In the patient whose case report follows the bone lesion was present for approximately 7 years before there was appreciable evidence of breaking down of the joint.

CASE 8. F. W., male, aged 12 years, had pain in the right hip for 6 years. The early roentgenogram, Figure 9, a, shows a small area of reduced density in the ilium bordering on the acetabulum and the Y-shaped cartilage. Treatment had consisted in plaster encasement of the limb. A roentgenogram taken 1 year later (Fig. 9, b) shows increase in the size of the osseous focus in the ilium with destruction of the neighboring bony articular cortex of the acetabulum. The capital epiphysis is slightly flattened but the cartilage space is normal. A roentgenogram (Fig. 9, c) taken 3 years later shows some increase in the size of the iliac lesion and sclerosis of its margins but no further evidence of joint destruction. On entry 6 years after the onset of symptoms, examination showed the hip only slightly limited in motion. The roentgenogram taken at this time (Fig. 9, d) shows the large area of decreased density in the ilium with sclerotic borders and small irregular flecks of greater density. The shadow of the articular cortex is absent over the involved portion of the acetabulum but it is intact over the lateral one-third and over the somewhat flattened femoral head. The cartilage space of the joint is slightly narrowed. Because of the absence of symptoms of active arthritis and the absence of definite roentgen findings of general involvement of the hip joint, an operation was done in which the muscles were reflected from the mesial surface of the ilium at the level of the anterior inferior iliac spine and the primary lesion was exposed through a window and curetted out. The cavity which measured 2 by 3 centimeters contained tuberculous granulations and pus. Its inferior wall was the acetabular roof, but no opening into the hip joint could be demonstrated. The operative wound healed without the formation of a sinus. The hip was immobilized in plaster for 7 months and then motion without weight bearing was permitted for 4 months. A roentgenogram (Fig. 9, e) taken at the end of this time shows almost complete filling in of the iliac lesion by bone and no additional evidence of general hip joint involvement. The patient was then allowed to walk. Fifteen months after the operation, however, there was increasing pain and stiffness of the hip and additional roentgenograms (Fig. 9, f) show further decrease in the cartilage space and lateral and medial erosion of the capital epiphysis. Active

Fig. 12. Case 9. Tuberculosis of the hip primary in the ilium. a, Fourteen months after onset. Area of reduced density, *x*, is present in the lateral portion of the ilium bordering on the acetabulum. The articular cartilage space is of normal width. The shadows of the bony articular cortices of the head and mesial portion of the acetabulum are intact. b, Ten months later. There is collapse of the acetabular roof with partial dislocation of the head of the femur and a spur of bone, *s*, from the ilium above the head; also a reduced cartilage space of the joint and a loss of the shadow of the bony articular cortex over the superior region of the capital epiphysis.

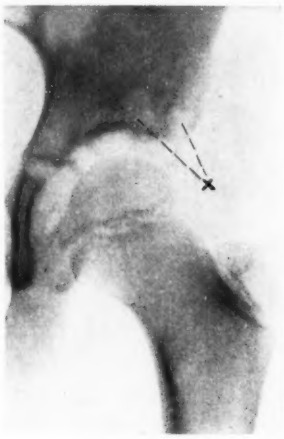


Fig. 12, a.

Fig. 12, b.

Fig. 13. Case 10. Tuberculosis of the hip primary in the ischium. a, Area of reduced density, *x*, in ischium near the Y-cartilage; no evidence of general involvement of the joint. b, Two years later. Loss of the articular cartilage space and the shadows of the bony articular cortices, partial dislocation and secondary invasions of the ilium, *y*, and the head; the primary ischial focus is now obscured.

Fig. 13, a.

Fig. 13, b.

tuberculosis of the hip joint was diagnosed and resection of the articular cartilages and arthrodesis by tibial bone transplants were done. The joint cavity about the femoral neck was found obliterated by adherent tuberculous synovia and the articular cartilage of the acetabulum was thinned but that of the head was relatively well preserved (Fig. 10). The joint had probably been involved early by a mild tuberculous process which was quiescent during the years of immobilization and was reactivated by the recent weight bearing. A photomicrograph (Fig. 11) of the lateral portion of the articular surface of the capital epiphysis shows the articular cartilage to be intact superficially but invaded and partially separated from the underlying bone by subchondral nonspecific granulation tissue which has broken down and has absorbed the bony articular cortex. Four months after operation there was bony ankylosis of the hip (Fig. 9, g).

In another case an iliac focus of tuberculosis was present before there was roentgen evidence of joint destruction, but extension soon resulted in an extensive breakdown of joint structures.

Case 9. E. K., female, aged 7 years, had limp for 2 years with increasingly severe pain. Figure 12, a, taken 14 months after onset of symptoms, shows an area of reduced bone density in the lateral portion of the ilium bordering on the acetabulum. The shadow of the articular cortex of the acetabulum is intact except at the lateral margin where it is indistinct. That of the femoral head is normal except for regional atrophy, and the cartilage space is normal. On hospital entry 10 months later there was markedly restricted motion of the hip. A roentgenogram (Fig. 12, b) taken then shows breaking down of the ace-

Fig. 14, a.

Fig. 14, b.

Fig. 14. Case 11. Primary metaphyseal tuberculosis with secondary extension into the capital epiphysis and the joint. a, Area of reduced density, *x*, mesially in the neck and extending into the capital epiphysis, moderate coxa vara, narrowed cartilage space of the joint, and indistinct shadows of the bony articular cortices indicating joint involvement. b, Two years after resection of the articular surfaces, and transplantation of the tibial bone. There is union of the transplants but the joint line is incompletely filled in by bone.

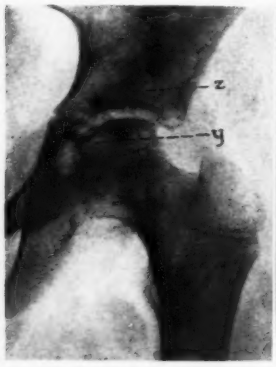


Fig. 15, a.

Fig. 15, b.

Fig. 15. Case 12. Secondary invasion of the capital epiphysis and ilium in tuberculous arthritis. a, Taken 5 years after onset, shows area of rarefaction, *y*, in the capital epiphysis, area of rarefaction and sclerosis, *z*, in the opposing ilium, a slightly narrowed cartilage space and reduced shadows of the bony articular cortices. b, Taken 2 years and 9 months after arthrodesis, shows areas of secondary invasion healed.

Fig. 16, a.

Fig. 16, b.

Fig. 16. Advanced tuberculosis of the hip with partial growth arrest. a, Shows destruction in the ilium, capital epiphysis, and neck of the femur with shadows in the head and neck of greater density than the surrounding atrophic bone; small osseous center of greater trochanter, *t*. b, Taken 3 years later, shows further destruction and upward displacement of the greater trochanter through the longitudinal growth of its epiphyseal cartilage disc.

a b c d

e

Fig. 17. Case 13. Tuberculosis of the hip without a demonstrable primary osseous focus: a, shows regional bone atrophy, normal shadows of the articular cartilage space and bony articular cortices; b, shows extra-articular iliac transplants across the joint; c, shows non-union and absorption of the femoral end of the transplants, a narrowed cartilage space, a reduced shadow of the bony articular cortices; d, taken 4 months later, shows union of the tibial transplants, further loss of the articular cartilage space and of the shadows of the articular cortices; e, taken 2 years and 9 months later, shows extra-articular arthrodesis but breakdown of the bone bordering on the joint.

tabular wall and partial dislocation of the femoral head into the area of iliac bone destruction. A spur of periosteal bone has formed lateral to the iliac lesion. The articular cartilage space is hazy and decreased and the shadow of the bony articular cortex is blurred over the superior central region of the capital epiphysis which is opposed to the iliac cavity.

At operation excision of the iliac focus and arthrodesis of hip were done. A tuberculous abscess was found under the psoas muscle. A cavity 2.5 centimeters in diameter in the ilium just above the acetabulum was found to extend into the joint through a perforation in the acetabular cartilage. Tuberculous synovitis was found to be present. The head of the femur which was partially dislocated was covered by articular cartilage which was thinned superiorly. The acetabular articular cartilage was markedly thinned. The articular cartilage of the acetabulum was curetted away and that of the femoral head was excised in such a way that the epiphyseal cartilage disc between it and the neck was not injured. The bony epiphysis was placed in contact with the denuded ilium and an iliac bone transplant was placed from the epiphysis to the ilium. Solid fusion was present after 9 months of cast immobilization. Microscopic examination of sections through the excised cartilage of the femoral head shows destruction of the bony articular cortex by non-tuberculous granulation tissue. No tuberculous tissue was found in the epiphyseal bone although there was extensive tuberculous synovitis.

Primary focus in the ischium. Primary tuberculous involvement of the ischium with secondary extension into the hip joint was observed in 2 childhood cases. In each of these, roentgenograms made early in the course of the disease showed an area of ischial bone destruction bordering on the Y-shaped cartilage of the acetabulum without evidence of extensive involvement of the rest of the joint. Subsequent roentgenological and pathological examination showed signs of extensive tuberculous arthritis with secondary bone invasions which obscured the point of primary ischial involvement. The following is 1 of the 2 cases.

Case 10. W. W., male, aged 13 years, had pain in the right hip and limp for 2 years. Figure 13, a, taken 6 months after the onset of symptoms shows an area of reduced density in the ischial portion of the acetabu-

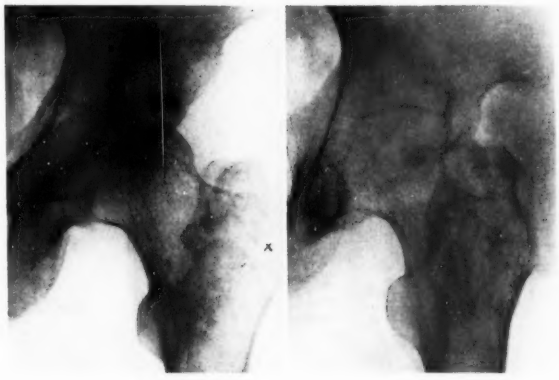
Fig. 18. Advanced tuberculosis of the hip with extensive secondary invasion and absorption in the innominate bone and loss of the head and part of the neck of the femur. Primary point undetermined.

Fig. 19. Case 14. Tuberculosis of the hip in an adult, primary in the greater trochanter. The roentgenogram shows irregular rarefaction of the trochanter, a narrowed cartilage space of the joint, loss of the shadow of the bony articular cortex of the femoral head, and reduction of its shadow on the acetabulum.

lar wall near the triangular cartilage. The shadows of the bony articular cortices and the articular cartilages are normal. At entry 2 years after the initial symptoms there was limitation of hip joint motion to one-half normal range. In the roentgenogram taken at this time (Fig. 13, b) there is extensive joint involvement as evidenced by a loss of the shadows of the bony articular cortices, subluxation, marked thinning of the cartilage space, and extensive secondary invasion and absorption in the ilium and the capital femoral epiphysis. At this time it would be impossible to identify the ischial change as the primary focus.

At operation, extensive tuberculous synovitis was found. The articular cartilages were thinned and loosened from the underlying bone. The cartilages were excised and full thickness tibial transplants were placed across the joint. Healing occurred but there was subsequently some absorption of the bone grafts and solid fusion was not present until 3 years after the operation.

Epiphyseal changes in childhood tuberculosis of the hip. In no instance of childhood tuberculosis of the hip was there evidence either in the roentgenograms or in the pathological specimens of a primary focus in the capital femoral epiphysis. The comparatively early destruction of the articular cortex as revealed by the reduction or loss of its density in the roentgenograms was found on microscopic examination to be due to the action of microscopically non-specific granulation tissue. This subchondral tissue composed of fibroblasts, numerous capillaries, round cells, and occasional foreign body multinucleated cells, apparently develops by proliferation of the vascular fibrous tissue normally present beneath the articular surfaces. It appears early in tuberculous arthritis but is not directly connected with the proliferating tuberculous synovia as shown by its presence while the cartilage covering of the head is still superficially intact. Although histologically non-tuberculous its peculiar action in breaking down the bony articular cortex with loosening and slow invasion of the articular cartilage makes it a characteristic pathological feature of tubercu-



a b

Fig. 20. Case 15. Tuberculosis of the hip in an adult, primary in the greater trochanter, secondary in the joint. a, Taken 3½ months after fracture of the greater trochanter, shows union with an area of reduced density, *x*, in the lateral portion of the fracture line. There is no evidence of joint involvement. b, Taken 17 months later, shows irregular reduction of density in the greater trochanter, a narrowed articular cartilage space, and loss of the shadows of the bony articular cortices which indicates tuberculous arthritis.

lous arthritis. Cases 3 and 8 illustrate the roentgenological and pathological characteristics of early epiphyseal changes due to subchondral absorption.

The failure to find evidence of primary localization of tuberculosis in the capital femoral epiphysis in children corresponds with experience in other joints such as the knee and ankle where the primary point of involvement when osseous is usually metaphyseal in location (5). Likewise, experience in pyogenic arthritis of the hip during childhood has shown that primary osseous involvement is frequent in the neck of the femur and ilium but is rare in the capital epiphysis (3).

Secondary invasion of the epiphysis by tuberculous tissue occurred by direct extension of the primary neck focus through the epiphyseal cartilage disc and by invasion from active tuberculosis within the joint. Epiphyseal involvement from a neck focus usually took place before there was extensive joint destruction and followed necrosis and absorption of a portion of the epiphyseal cartilage. In some cases the entire bony epiphysis was secondarily involved while in others localized destruction with cavity formation resulted. The following case is one of a primary metaphyseal localization of tuberculosis with secondary extension into the epiphysis and joint.

Case 11. W. H., male, aged 8 years, had limp and mild pain in the left hip for 6 years. On examination there was found only slightly limited motion. Figure 14, a, shows an area of reduced density in the inferior region of the neck and epiphysis. The articular cartilage space is only slightly reduced and the shadows of the bony articular cortices are lost and the bony margins are fuzzy. There is moderate coxa vara and a bony bridge is present between the central portion of the capital epiphysis and metaphysis which suggests an earlier growth arrest.

At operation, an extensive tuberculous synovitis was present. A cavity containing granulations occupied the inferomesial portions of the metaphysis and epiphysis. The articular cartilages were loosened from the underlying bone and in the region of cavitation the femoral articular cartilage was depressed. The articular cartilages were removed and tibial transplants were placed across the joint. Two years later there was a bony bridge from the ilium to the femur in the region of the transplants but the joint line was still incompletely filled in with bone (Fig. 14, b).

In most of the advanced cases of tuberculous arthritis the capital epiphysis was secondarily involved by extension of tuberculosis from the joint. This usually occurred late in the disease after the articular cartilages had been extensively absorbed, but sometimes localized areas of secondary invasion occurred before there was advanced joint destruction. Such invasions usually produced necrosis and absorption of bone and left cavities not only in the capital epiphysis but also in the opposing acetabular bone. The destruction of bone on both the femoral and pelvic sides of the joint and the failure to find such areas of epiphyseal bone destruction in the early stages of arthritis clearly indicated the secondary rather than primary nature of such lesions. An example of secondary invasion of both the epi-

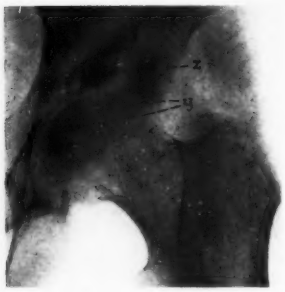


Fig. 21. Case 16. Secondary bilateral bone invasion in tuberculosis of the hip in an adult. The roentgenogram shows a narrowed cartilage space and loss of the shadows of the bony articular cortices except over the superior region of the joint where triangular shadows of greater density than the surrounding atrophic bone indicate the presence of kissing sequestra in the femoral head, *y*, and in the opposing ilium, *z*.

physeal and acetabular bone which left opposing areas of bone absorption is furnished by the following case.

CASE 12. C. G., female, aged 8 years, had slight pain in the left hip for 5 years with more severe symptoms during the last year. On examination there was found slight restriction of joint motion. Figure 15, a, shows the articular cartilage space to be narrowed and the shadows of the bony articular cortices are

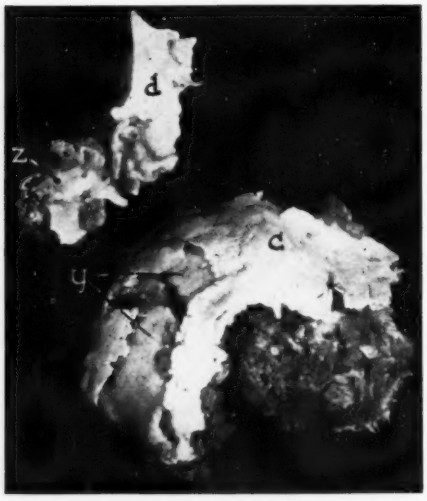


Fig. 22. Case 16. Photograph of the excised articular surfaces showing sequestra, *y*, in the femoral head, exposed centrally but partially covered peripherally by necrotic cartilage, *c*; iliac sequestrum, *z*; and acetabular articular cartilage, *d*.

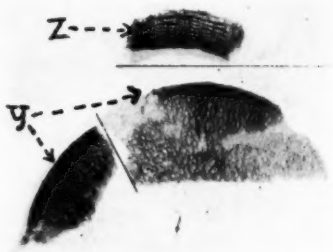


Fig. 23. Case 16. Roentgenogram showing a similar density of the bone in kissing sequestra in the head of the femur, *y*, and ilium, *z*. The surrounding living bone in the femoral head is reduced in density.

fairly well marked over the superior portion of the joint but are diminished mesially on both the acetabulum and the head. Opposing areas of rarefaction with sclerotic margins are seen in the ilium and the capital epiphysis.

At operation, tuberculous synovitis was present. Microscopic sections of cartilage and bone removed from the superior portion of the joint showed undermining and absorption of the deep cartilage layers by granulations composed of fibroblasts, round cells, and occasional foreign body multinucleated cells. Arthrodesis of the joint was done, full thickness tibial bone transplants being used. Bony fusion was present 6 months later. Figure 15, b, shows fusion 2 years and 9 months after operation with healing and bony repair of the areas of destruction. The cavity in the head of the femur in this patient approaches most nearly that which might be expected in a patient with primary involvement of the epiphysis. The 5 year duration of the disease, however, and the presence of a similar area in the opposing acetabulum make it clear that both lesions are secondary invasions.

Although tuberculous invasion of bone during childhood usually results in necrosis followed by complete absorption, there was in the case of an adolescent female a bilateral secondary invasion of tuberculosis from the joint which produced opposing sequestra which persisted in a manner commonly found in the tuberculous arthritis of adults.

Secondary bone invasions which occurred after the tuberculous arthritis was advanced frequently resulted in a gradual breakdown of the femoral head and acetabulum. The breaking down usually began in the superior portion of the femoral epiphysis and in the iliac portion of the acetabulum probably because of greater pressure on those opposing surfaces. The late roentgenograms in Cases 7 and 10

demonstrate this tendency to more advanced bone destruction at the points of pressure.

Destruction of the cartilage disc between the capital epiphysis and neck resulted in arrested longitudinal growth through the neck. When this occurred in young children there was usually continued longitudinal growth for some time at the epiphysis of the greater trochanter resulting in its elevation above the level of the hip joint. This is demonstrated in Figure 16, a, which is a roentgenogram of a 3 year old child and shows extensive destruction in the ilium, the capital epiphysis, and the neck of the femur with irregular shadows in the head and neck which are of greater density than the surrounding atrophic bone which is indicative of sequestra. The small osseous center of the greater trochanter is atrophic but appears uninvolved. Figure 16, b, taken 3 years later, shows further destruction of the joint and upward displacement of the greater trochanter through longitudinal growth of its epiphyseal cartilage disc. The necrotic bony fragments of the head and neck have been almost completely absorbed except for small fragments which have become separated and displaced laterally and distally along the diaphysis. The capital epiphysis, epiphyseal cartilage disc, and metaphysis have been destroyed leaving only the distal portion of the femoral neck. In Case 11 (Fig. 14) there was partial growth arrest at the mesial portion of the epiphyseal line between the head and neck resulting in moderate coxa vara.

Tuberculous arthritis of undetermined origin: primary synovial tuberculosis. In 44 of the patients it was not possible to state the part of the joint structure in which the infection started. Nine of these were observed early in the course of the disease without finding evidence of a bone lesion which could be considered primary. Roentgenograms taken at later periods showed evidence of secondary bone invasion in most of them. The primary site of joint involvement in these patients may have been in the synovia but it is possible also that small osseous foci which were not detectable in the roentgenograms were present. The roentgenograms taken of the patient whose case report follows showed no evidence of an early osseous focus, and this may have been primary in the synovia. Late invasion and destruction of bone on both sides of the joint is demonstrated.

CASE 13. H. E., male, aged 4 years, had pain in the left hip and knee for 4 months. Examination showed restricted motion at the left hip. Figure 17, a, shows slight regional bone atrophy but no evidence of joint destruction or of a primary osseous focus.

At operation biopsy of the joint and extra-articular arthrodesis by iliac bone grafts were done, as shown in the roentgenogram (Fig. 17, b). Microscopic sections of the synovia showed tuberculosis. Four months later there was non-union of the bone grafts to the femur and at the end of 1 year they were absorbed at the femoral end as shown in Figure 17, c. Here the articular cartilage space is diminished and the shadows of the bony articular cortices are indistinct. A second operation was done placing full thickness tibial bone transplants from the ilium to the femoral neck and trochanter. The roentgenogram (Fig. 17, d) made 4 months later shows union with the transplants, further loss of the articular cartilage space, and breaking down of the superior portion of the capital epiphysis. Two years and 8 months later there was solid ankylosis of the hip but the roentgenograms (Fig. 17, e) taken then show advanced destruction of the superior region of the epiphysis, the neck, and to some extent the ilium. In this case late bone destruction took place although extra-articular arthrodesis was accomplished.

In 36 patients, advanced destruction of the joint structures made it impossible to determine accurately either pathologically or roentgenologically the primary site of the joint involvement. It is logical to assume that earlier roentgen examinations of some of these patients would have disclosed primary osseous foci. Destruction more advanced on one side of the joint than on the other in some patients suggested that the primary involvement had been in the bone which showed the greater destructive lesion. This could not be depended upon in determining the primary site, however, for in several early cases followed through the course of the disease, as in Case 10, a small primary bone lesion later became obscured in the roentgenograms by massive secondary bone invasion in other parts. The major bone destruction frequently occurred in a region other than that of the primary site. Massive invasions of the innominate bone or of the femur were more commonly due to secondary extension from the joint than to increase in the size of a small primary lesion situated in

either bone. Usually when the bone on one side of the joint was extensively invaded secondarily the other side showed a corresponding degree of destruction. Secondary extension into the femur usually involved the capital epiphysis and adjacent neck but less often the base of the neck, shaft, or trochanter. An unusually extensive secondary invasion of innominate bone and destruction of the head and neck of the femur is shown in the roentgenogram (Fig. 18) of a 10 year old female who had had untreated tuberculosis of the hip joint for 7 years. This case illustrates well the impossibility of determining the primary point of joint involvement in the late stages of the disease. Isolated secondary invasions of the neck of the femur were not observed and the finding of a single destructive lesion in this location even late in the disease is good evidence that it was the primary site of infection.

TUBERCULOSIS OF THE HIP JOINT STARTING IN ADULT LIFE

In 9 out of 12 patients with tuberculosis of the hip which started in adult life, no demonstrable primary bone focus could be made out either roentgenologically or pathologically. Three primary bone foci were observed, 2 in the greater trochanter and 1 in the ilium above the acetabulum. The 2 primary lesions in the trochanter extended into the hip joint and produced extensive tuberculous arthritis. One of them developed following a fracture of the trochanter in an adult who had active pulmonary tuberculosis. The primary osseous lesion in the ilium occurred in an individual with active pulmonary tuberculosis and had not extended into the hip joint at the end of the second year. The following 2 cases were primary in the trochanter and extended secondarily to the joint.

CASE 14. M. D., male, aged 45 years, had pain about the left hip for 5 years, stiffness for 2 years, and swelling of the thigh for 1 year. Examination showed a large fluctuant mass located laterally in the upper thigh. Motion at the joint was limited and painful. The roentgenogram, Figure 19, shows marked destruction of the greater trochanter with displacement of its superior portion. The cartilage space of the joint is narrowed and the shadow of the bony articular cortex is lost over the femoral head and is diminished over the acetabulum. A diagnosis of tuberculosis primary in the trochanter and secondary in the hip joint was made and operation was done. A large abscess with sinuses leading into the partially destroyed trochanter was evacuated and the diseased bone cleaned out. Bone transplants were placed extra-articularly from the ilium to the femoral shaft. Microscopic examination and guinea pig inoculation showed tuberculosis. Fourteen months later there was failure of fusion of the transplants to the femur and a second operation was done. The hip joint was entered and extensive tuberculous synovitis was found. The articular cartilages were found loosened from the subchondral bone. The articular surfaces of the top of the head and of the acetabulum were denuded and tibial transplants were placed across the joint. Abscesses and sinuses formed with later sequestration of the grafts which had to be removed. Marked infection persisted and 2 years later the patient died.

CASE 15. M. C., male, aged 37 years, had had occasional pain in the left knee since the age of 16. Eleven years ago he sustained a T-shaped fracture of the lower end of the left femur and following this he had symptoms of active tuberculosis of the left knee which was later excised and arthrodesed. Twenty months before entry the patient sustained a simple fracture of the left greater trochanter in an automobile accident. Solid union and good function were present after 8 months but 1 year after injury increasing stiffness and pain at the hip were noted. Figure 20, a, shows early union of the fractured trochanter 3½ months after injury and an area of reduced density in the lateral portion of the old fracture line. The hip joint appears uninvolved at this time. At entry 17 months later there was marked restriction of motion at the hip and x-ray evidence of an old active pulmonary tuberculosis. Figure 20, b, shows irregular areas of reduced density in the greater trochanter, loss of the articular cartilage space, and loss of the shadows of the bony articular cortices. A diagnosis of tuberculosis of the trochanter with secondary extension to the hip joint was made and operation of excision of the articular cartilages and arthrodesis with tibial transplants was done. An abscess in the trochanter was found and the material cleaned out. Microscopic examination revealed tuberculous granulation tissue. The articular cartilages were found loosened from the underlying bone and were markedly thinned. Bony ankylosis was present 14 months after operation.

In contrast to other joints such as the knee and ankle, primary epiphyseal foci located in the juxta-articular region were not found in any of the tuberculous hips of adults. The femoral neck which was so frequently primarily involved in children was not the site of a primary osseous lesion in any of these.

Secondary bone invasion in adults. Secondary invasion of the femoral head and ilium in

tuberculosis of the hip joint in adults was relatively frequent. In 3 of the 12 adult patients, bilateral sequestra were found. These sequestra developed late in the course of active tuberculous arthritis and their bilateral nature indicated that they were the result of secondary invasions of bone, as reported by one of us (4), and were not primary foci resulting from embolism as reported by Koenig (1). Their location in the superior portion of the femoral head and in the opposed region of the ilium suggests that pressure played a rôle in their formation. The iliac sequestra were smaller than the opposing ones in the femur and extensive regional absorption of the ilium in 2 patients left cavities in which the sequestra lay. In the femoral head the sequestra were loosened from the surrounding living bone but extensive absorption of the necrotic bone did not take place. Secondary bone invasion with formation of kissing sequestra is illustrated in the following case.

CASE 16. R. R., male, aged 20 years, had limp and pain in the left hip for 11 months. Figure 21 shows narrowing of the articular cartilage space and loss of the shadows of the bony articular cortices over the mesial portions of the head and acetabulum. In the superior portion of the femoral head there are two triangular shadows of density greater than the surrounding bone, almost separated from each other by a V-shaped notch and from the underlying bone by a narrow zone of reduced density. The articular surfaces of the more dense areas are sharply defined. In the opposing region of the acetabulum there is a large area of reduced density surrounding a sequestered fragment of articular cortex and underlying bone of a density similar to the areas in the head of the femur. A diagnosis of tuberculous arthritis with secondary bilateral invasion and sequestration of the articular bone was made and operation was done. Tuberculous synovitis was proved by microscopic examination and guinea pig inoculation. The articular cartilages were found extensively eroded and loosened from the bone. The femoral head, a photograph of which is shown in Figure 22, contained two almost completely separated sequestra. Its articular cartilage was extensively thinned and loosened from the underlying bone and over the sequestra it had been worn away and exposed the polished articular surface of the necrotic bone. The acetabular articular cartilage was thinned and loosened marginally but was absent over the region of cavitation in the ilium which measured 2 by 2 centimeters. A small sequestrum of articular bone was removed from the cavity. The articular portion of the head of the femur was excised, the walls of the acetabulum were curetted, and tibial transplants were placed across the joint. Figure 23 is a roentgenogram of the sequestered portions of the femoral head and ilium. The similarity in densities and size of the trabeculæ of the kissing sequestra indicates that necrosis occurred simultaneously on the two sides of the joint and is evidence in support of their secondary rather than primary nature.

In 2 cases of advanced tuberculous arthritis in adults small areas of secondary bone invasion in the ilium were observed in roentgenograms made late in the disease. Earlier roentgen examinations showed no bone foci. Pathological examination disclosed cavities in the ilium which contained tuberculous granulation tissue with small fragments of sequestrated articular cortex.

SUMMARY AND CONCLUSIONS

Eighty-two cases of tuberculosis of the hip have been studied roentgenologically and 56 pathologically in an attempt to determine the point of primary involvement of the joint structure. The studies were made at varying times in the course of the disease. In general, the earlier they were obtained the greater the frequency with which the primary point of infection was located. In 70 patients the disease began in childhood, while in 12 it began in adult life. In the childhood cases it was possible to determine that the primary point of infection was in the bone bordering on the joint in 26, as follows: neck of the femur adjacent to the head, 14; ilium bordering on the acetabulum, 10; ischium bordering on the acetabulum, 2. It is to be noted especially that in no patient was a primary lesion identified in the head (epiphysis) of the femur. In all of these patients except 2 in whom the disease started in the neck (metaphysis) of the femur it sooner or later broke into the hip joint and resulted in a diffuse tuberculous arthritis.

In the 44 remaining childhood cases it was impossible to determine the primary point of infection, whether in the synovia, the metaphysis, or the epiphysis. In most of the patients the examinations were made after there had been secondary invasion and breaking down of bone on both sides of the joint, which was sufficient to obscure or to destroy completely the primary focus in those in whom it was located in the bone. Care has to be

exercised not to mistake an area of bone secondarily invaded in the acetabulum or especially in the head of the femur for a primary osseous focus.

In 9 patients the examination was made early before there was appreciable breaking down of the ends of the bones, and no primary osseous focus was identified which would speak for primary localization in the synovia. However, it is impossible in such cases to rule out with certainty a primary osseous focus which was so small that it escaped detection in the roentgenograms or in the rather incomplete pathological examinations that could be made of the tissue excised at operation.

In the 12 patients in whom the disease began in adult life, the lesion was identified as primary in the greater trochanter in 2, with secondary invasion of the joint. In 1, it was primary in the ilium. In the 9 remaining, it is impossible to state whether the lesions were primary in the synovia or in the bone because of the difficulty of recognition of very small primary osseous foci and because of the extensive secondary invasion and destruction of bone that was present in some cases. It is noteworthy that primary localization of tuberculosis at the hip in these patients is similar to that of pyogenic infection of the same region which is known to be rare in the capital epiphysis and common in the femoral metaphysis and ilium.

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BLOOD VOLUME CHANGES DURING SURGICAL PROCEDURES

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CHANGES in blood volume incident to surgical procedures are a chief concern for the surgeon. Actual blood loss is a generally recognized factor, but it may not be the most important consideration to be thought of in surgical procedures. In addition there must be considered: (1) anesthesia, with its effect upon respiration, arterial tension, and capillary and venous tone; (2) trauma to tissue and handling of viscera with response of the autonomic nervous system; (3) changes in ventilation, affecting insensible water loss and hence the fluid reserve; and (4) the efficiency of the organism in its response, immediate or late, to hemorrhage. Postoperatively, influential factors are the changes occurring during recovery from anesthesia and the effects of the relatively high environmental temperatures to which patients usually are subjected for the first few hours following operation. Of interest also are the effectiveness of fluids administered by mouth or parenterally in restoring blood volume and the possibility of dangerously augmenting the volume by excessive administration of fluids.

Gatch and Little, Maddock and Coller, and Pilcher and Sheard have measured actual blood lost at operation, the method employed being the determination of hemoglobin content of washings of drapes, sponges, etc., used at operation. The results of these separate studies agree closely, and little doubt exists as to the accuracy of the findings. Blood losses range from a few cubic centimeters in minor procedures (appendectomy, herniorrhaphy) to 200 to 300 cubic centimeters in major laparotomies (cholecystectomy, hysterectomy), and may reach 700 to 1,250 cubic centimeters in such procedures as radical mastectomies.

It is possible, however, that the change in circulating blood volume, which influences the condition of the patient during and after operation, may be far greater than due to blood loss alone. Aikawa, using the carbon monoxide method of blood volume determination, observed decreases in total volume ranging from 5 to 39 per cent, averaging about 20 per cent, in 42 of 43 dogs subjected to various abdominal operations. Derra (3) employed a combination of the carbon monoxide and dye methods in studying changes in volume in dogs under avertin anesthesia and observed either increases or decreases in total volume, the extremes ranging from decreases of 28 per cent to increases of 45 per cent of pre-operative values. Schneider and Polano, using the carbon monoxide method, noted a diminution in plasma volume coincident with a fall in minute volume early in anesthesia. Derra (4) observed in dogs undergoing laparotomies that the plasma volume tended to fall and cell volume to rise but with decrease in total volume.

Reissinger and Schneider, using the carbon monoxide method, measured blood volume before and after operation in humans and observed increases of 100 to 1,420 cubic centimeters as well as decreases of 690 to 2,851 cubic centimeters. In all cases the blood pressure was lower after operation than before.

In this communication we report the results of studies on 12 patients, selected from the surgical wards of the Peter Bent Brigham Hospital, in whom blood volume changes were determined during the actual surgical procedure and during the recovery period.

METHODS

Plasma, cell, and total blood volume were determined by the dye method described by Gibson and Evans (6). This method measures the plasma volume by determining the dilution in the blood stream of an accurately measured amount of an azo dye, "Evans blue," after intravenous injection. The dilution factor used is obtained by extrapolation of the slope of disappearance of the dye from the

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blood stream to time of dye injection. The disappearance slope is constructed from the dye concentrations, as determined with spectrophotometer, of a series of blood serum samples taken over a period of 30 minutes after dye injection. The result obtained represents the plasma volume at time of dye injection. Red cell and total volumes are calculated from plasma volume and hematocrit values.

Studies were made in 9 patients by the "direct" method of repeated volumes, a separate dye injection being made for each determination and successive volumes being corrected for blood withdrawn in sampling for preceding volume determinations. Studies of changes occurring during the induction of anesthesia were made in 8 patients by the short "indirect" method. In this procedure the disappearance slope following the injection of dye for the initial volume is first determined over a period of 40 minutes. Samples are then taken during the administration of the anesthetic, and from the initial plasma volume and the deviation of dye concentration of these samples from the prolongation of the disappearance slope, changes in plasma volume are calculated. By this method small changes in plasma volume can be measured accurately.

Changes in volume occurring during operation were followed by the long "indirect" method in 3 patients. In this procedure the initial plasma volume is determined on the afternoon of the day preceding the operation. The disappearance slope is determined the following morning and changes during operation are calculated from the initial plasma volume and the deviation of dye concentration of blood serum samples taken during operation from the prolongation of the disappearance slope. A study of this type is shown in Chart 1. This method permits of making determinations of the plasma volume at any time during operation without another injection of dye.

RESULTS

Anesthesia. Four patients were studied during nitrous oxide-oxygen induction and ether anesthesia, 2 during avertin induction and ether anesthesia, 1 during local regional anesthesia with novocain, and 1 during spinal anesthesia with novocain. Pre-operative changes in blood volume during anesthesia in these patients are summarized in Table I.

In every case the induction of anesthesia was accompanied by a slight but definite decrease in the plasma volume. The diminution in plasma volume is temporally related to elevation of blood pressure and pulse and respiratory rates. In 2 patients, Cases 253 and 270, in whom anesthesia was induced with avertin, no change in blood pressure occurred, and the plasma volume was but slightly reduced. Following the administration of ether, no change in pressure or volume occurred in Case 253, but in Case 270 a sharp rise in pressure took place, accompanied by a definite decrease in plasma volume. In Case 255 a considerable elevation in blood pressure occurred during gas-oxygen and ether induction of anesthesia, accompanied by a striking decrease in plasma volume. In Case 260 basal blood pressure was elevated, gas-oxygen-ether induction was accompanied by an initial further rise and subsequent fall in pressure, and plasma volume remained fairly constant. In 1 patient, Case 268, who was operated upon under local novocain anesthesia, infiltration was followed by a sharp rise in pressure, and the plasma volume was diminished.

Variable fluctuations in cell volume occurred. In the 4 patients anesthetized with gas-oxygen and ether it increased in 1 and was slightly reduced in 3. An increase occurred in the 2 cases in which avertin was used, Cases 253 and 270, while in the 2 cases in which novocain was used, Cases 268 and 290, a decrease took place. Thus the cell volume was diminished in 4 and increased in 4 of these patients. Yet in all but 1 case (Case 290) the hematocrit value rose with the induction of anesthesia, indicating a slight hemoconcentration.

As regards total volume, it may be said in general that the degree of reduction therein, due chiefly to loss of fluid from the blood stream, parallels the degree of elevation of blood pressure.

Effect of surgical procedure. The course of changes in plasma and total volume was followed through the period of operation in 3 patients, and during the immediate postoperative period in 2 of these 3, the changes being

TABLE I.—CHANGES IN BLOOD VOLUME DURING INDUCTION OF ANESTHESIA IN RELATION TO BLOOD PRESSURE, PULSE, AND RESPIRATORY RATES

	Nitrous oxide and oxygen with ether											
	Herniorrhaphy 7-23-36 No. 226 M 38 yrs.			Hysterectomy, appendectomy 12-1-36 No. 254 F 39 yrs.			Incision and suture of hemorrhoids 12-3-36 No. 255 M 39 yrs.			Cholecystectomy 12-17-36 No. 260 F 49 yrs.		
Anesthesia level	Basal	Early	Deep	Basal	Light	Deep	Basal	Deep	Deep	Basal	Light	Deep
Plasma volume, c.cm.	3670		3510	2310	2190	2155	2530	2450	2380	2060	2035	2040
Cell volume, c.cm.	2840		3060	1170	1125	1145	2850	2800	2810	1780	1740	1770
Total blood volume, c.cm.	6510		6570	3480	3315	3300	4470	4250	4190	3840	3775	3810
Hematocrit cells, per cent	43.6		46.5	33.5	33.9	34.7	42.3	42.3	43.1	46.0	46.2	46.5
Blood pressure, mm.Hg.	160/60		110/80	130/80	140/87	150/98	110/80	127/83	140/95	190/90	205/105	180/85
Pulse, per min.	100		75	60	163	158	68	80	108	110	105	90
Respiration, per min.	20		22	13	28	30	20	24	30	20	22	22

	Rectal avertin and ether						Local infiltration with novocain			Spinal novocain		
	Herniorrhaphy No. 253 M 30 yrs.			Resection of colon No. 270 F 48 yrs.			Gastric resection No. 268 M 63 yrs.			Herniorrhaphy No. 290 M 17 yrs.		
Anesthesia level	Basal	Early	Deep	Basal	Early	Deep	Basal	Early	Deep	Basal	Early	Deep
Plasma volume, c.cm.	3620	3530	3565	2210	2190	2060	2450		2350	2260		2200
Cell volume, c.cm.	3270	3350	3445	950	970	890	1190		1170	2210		2055
Total blood volume, c.cm.	6890	6880	7010	3160	3160	2950	3640		3520	4470		4260
Hematocrit cells, per cent	47.5	48.7	49.1	30.0	30.5	30.1	32.6		33.1	49.4		48.2
Blood pressure, mm.Hg.	120/80	120/80	120/80	140/60	140/60	170/70	120/80		150/90	130/70		130/70
Pulse, per min.	60	78	90	150	155	165	80		120	80		75
Respiration, per min.	20	20	26	24	24	35	23		30	22		20

as illustrated in Charts 1, 2, and 3. In these cases particular care was taken to prevent loss of blood and no considerable amount of bleeding occurred. The blood plasma withdrawn in sampling, not exceeding 60 cubic centimeters during the operation period, was replaced by intravenous injection of equivalent amounts of normal saline, and results were corrected for the small amount of red cells withdrawn.

In Cases 226 and 224, small fluctuations in plasma volume and total volume occurred, never greater than 100 to 150 cubic centimeters. These changes can be related to changes in blood pressure associated with the opening of the peritoneum and the handling of viscera. An elderly man, Case 268, with advanced carcinoma of the stomach, in whom local novocain was used, underwent a resection of the pyloric end of the stomach and a Billroth I anastomosis. The course of plasma and total blood volume bore an inverse relationship to changes in blood pressure during the operation. The volume remained below the pre-anesthesia level throughout operation and a repeated volume determination at the end of the operation revealed a net decrease in total volume of 250 cubic centimeters. In our opinion this decrease was not due to blood lost during operation but represents a change in volume due to physiological changes in response to trauma of operative procedures.

As shown in Table II, in 10 of the 12 cases in this series the total volume determined at the end of operation was below pre-operative levels, reductions ranging from 60 to 265 cubic centimeters and averaging 154 cubic centimeters. In the 2 other cases slight increases amounting to about 50 cubic centimeters took place. In 1 case plasma volume was unchanged, in 11 reduced, extremes ranging from 10 to 290 cubic centimeters, averaging 145 cubic centimeters. Red cell volume was re-

TABLE II.—POSTOPERATIVE CHANGES IN BLOOD VOLUME

Case number		230	247	254	224	226	231	255	257	260	268	270	290
Age and sex		38 M	48 F	39 M	30 F	38 M	42 M	39 M	30 M	49 F	63 M	48 F	17 M
Operation and date		Tonsillectomy 7-31-36	Perineal repair 11-17-36	Hysterectomy 12-1-36	Herniorrhaphy 7-22-36	Herniorrhaphy 7-23-36	Excision of pilonidal sinus 8-6-36	Hemorrhoidectomy 12-3-36	Herniorrhaphy 12-8-36	Cholecystectomy 12-17-36	Pyloric resection 12-31-36	Resection of colon 1-6-37	Herniorrhaphy 5-29-36
Initial volume	Plasma, c.cm.	3180	2080	2310	2765	3670	2845	2530	3620	2060	2450	2210	2260
	Cell, c.cm.	2870	1540	1170	2660	2840	2405	1850	3270	1780	1190	950	2210
	Total blood, c.cm.	6050	3620	3480	5325	6510	5250	4420	6890	3840	3640	3160	4470
	Hematocrit cells, per cent	47.3	42.5	33.5	48.0	43.6	45.8	42.3	47.5	46.0	32.6	30.0	49.4
Postoperative volumes	Hours, minutes postoperative	2°0′	0°10′	0°10′	0°30′	0°36′	0°30′	0°20′	0°20′	0°30′	1°05′	0°20′	0°20′
	Plasma, c.cm.	3040	1900	2160	2680	3380	2730	2520	3480	1955	2240	1975	2260
	Cells, c.cm.	2810	1455	1135	2605	3170	2470	1940	3380	1785	1180	1025	2105
	Total blood, c.cm.	5850	3355	3295	5265	6550	5130	4460	6760	3740	3420	3000	4370
	Hematocrit cells, per cent	47.6	43.2	33.9	48.8	48.3	46.4	42.1	48.3	47.2	33.8	31.5	48.1
	Change in total volume, c.cm.	—200	—265	—185	—60	+40	—120	+40	—130	—100	—220	—160	—100
	Weight loss, kilograms	0.9		0.8	0.4		0.8	0.8	0.3	1.0	0.5	1.5	
	Hours, minutes, postoperative		2°10′			2°21′						3°43′	2°30′
	Plasma, c.cm.		2035			3150						2110	2280
	Cells, c.cm.		1545			2875						740	1940
	Total blood, c.cm.		3580			6025						2850	4220
	Hematocrit cells, per cent		43.0			47.7						25.3	46.1
	Change in total volume, c.cm.		40			485						—310	—150
	Weight, loss		0.8			1.8						+0.2	+0.4
Remarks		See Note 1	See Note 2	See Note 3	See Note 4	See Note 5	See Note 4	See Note 4	See Note 4	See Note 4	See Note 6	See Note 7	See Note 8

[1]Moderate bleeding. [2]Persistent oozing.
[3]2 degrees anemia, hemostasis good.
[4]Little bleeding.
[5]Little bleeding. Profuse perspiration in "ether" bed.
[6]2 degrees anemia. Little bleeding.
[7]2 degrees anemia. 1,175 c.cm. normal saline intravenously between 2d and 3d volume.
[8]950 c.cm. saline intravenously between 2d and 3d volume.

duced in 6 patients, the extremes ranging from 10 to 85 cubic centimeters, averaging 43 cubic centimeters; and increased in 6 patients, the extremes ranging from 5 to 330 cubic centimeters, averaging 112 cubic centimeters. In general, weight loss bore a direct relation to the degree of reduction in total volume.

Thus it is apparent that total volume is diminished at the end of operation, but that an active response of the organism to blood loss, in the form of an influx of red cells into the circulation, takes place during operation.

The recovery period. That the reduction in the level of the blood volume during the immediate postoperative hours is not due to blood loss at operation alone is evident from data presented in Chart 1. This patient, Case 226, experienced a greater reduction in total blood volume during recovery, amounting at its height to about 500 cubic centimeters, than at any time during operation. This change took place after the patient had been placed in the routine "ether" bed; during which period no fluids were given, perspiration was observed to be moderately profuse, and room temperature was relatively high (85 degrees F.). In Case 224 the total volume was slightly increased at the end of operation, due to an increase in cell volume large enough more than to offset the diminution in plasma volume. However, observations made after 2 hours in the "ether" bed indicate a continued loss of

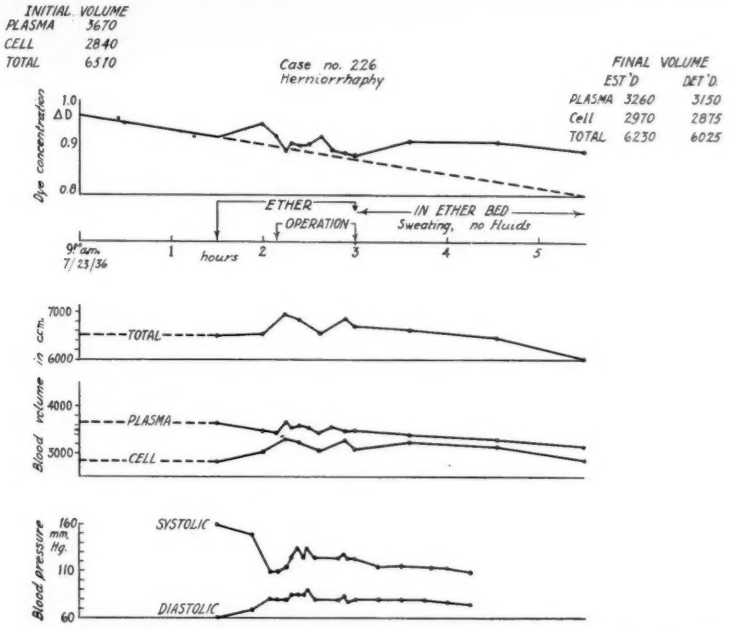

Chart 1. Changes in plasma, cell, and total volume in a patient (Case 226) undergoing herniorrhaphy under ether anesthesia. The method of determining plasma volume at various times during operation from dye concentration value of the prolongation of the disappearance slope and of the blood serum samples is shown. The final re-determined volume checks closely with the final estimated volume. Slight changes in volume occurred during anesthesia and operation. The red cell volume increased. During recovery in an "ether" bed, a marked diminution in plasma volume took place; reduction in total volume exceeded blood lost at operation.

plasma and a reduction in circulating cell volume to pre-operative level.

Restoration of depleted blood volume. Two cases in Table II are of particular interest in this respect. One patient, Case 247, in whom there was obvious bleeding, had a reduction in total volume of 265 cubic centimeters at end of operation, or 7.3 per cent of pre-operative volume, yet several hours later, although no fluids were given, plasma and cell volume were almost completely restored. This patient did not perspire freely in "ether" bed.

In contrast, another patient, Case 225, experienced a reduction in total volume of 525 cubic centimeters in a little over 2 hours after the end of operation, during which period no fluids were given. This patient was operated upon on a warm day and was observed to sweat profusely in the "ether" bed.

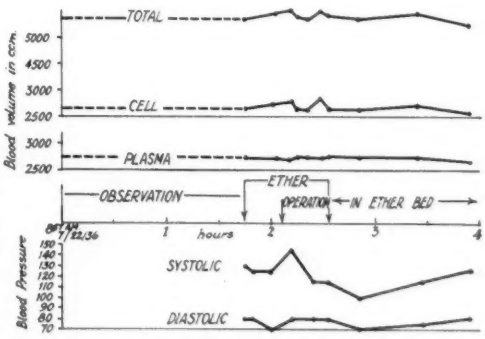

Chart 2. Blood volume changes in a male patient aged 30 (Case 224) undergoing bilateral herniorrhaphy under ether anesthesia. Very little change in plasma volume occurred during anesthesia or operation, but there was a marked increase in red cells resulting in an increase in total volume. During recovery no marked diaphoresis was noted in this patient and there was no considerable loss of plasma.

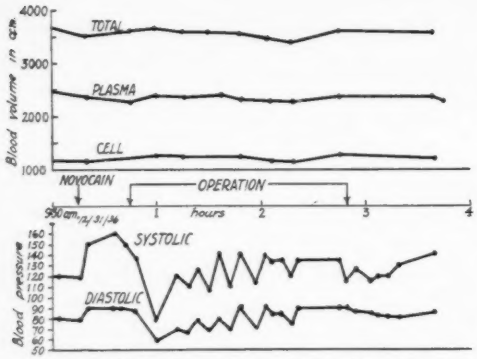

Chart 3. Blood volume changes in a male patient aged 63 (Case 268) with carcinoma of the stomach and secondary anemia undergoing gastric resection and a Billroth I anastomosis under local infiltration with novocain. A definite diminution in plasma volume accompanied the elevation in blood pressure following novocain injection, followed by an increase coincident with a drop in blood pressure when the abdominal cavity was opened. The influx of red cells was not marked in this anemic patient although the level was well sustained.

To 2 patients, Cases 270 and 290, were given postoperatively 1,000 cubic centimeters of normal saline intravenously. Both of these patients showed moderate reductions in total volume at the end of operation. In both cases volume determinations made after the completion of fluid administration showed a slight increase in plasma volume over the immediate postoperative level, but a definite decrease in total volume was shown, even from the pre-operative level, due to marked diminution in circulating cell volume. Both patients showed slight gain in weight over pre-operative values.

In this study we have not encountered the extreme reductions or increases in blood volume after operation, as observed in dogs by Aikawa and Derra (3) or in humans by Reissinger and Schneider and Schneider and Polano. In practically every instance in our series the plasma volume as determined post-operatively was lower than the pre-operative level. We conclude that the variable findings of the above authors arise from errors in the techniques employed, as previously described (6).

EVALUATION OF OBSERVATIONS

It is apparent that the changes in blood volume during the induction of anesthesia bear a direct relationship to the rise in blood pressure experienced. This finding is in keeping with observations made by us on the prompt and considerable decrease in volume that accompanies sudden elevation of systemic pressure, due to exercise or the intravenous injection of insulin or adrenalin. It is suggested that this lowering of plasma volume is due to a disturbance of the normal filtration-absorption balance of the capillaries brought about by an increased pressure gradient from the afferent to the efferent end of the capillaries, more fluid being forced out into tissue spaces at the proximal end than can be re-absorbed at the distal end. That this mechanism operates in a reversible manner is suggested by increases in plasma volume seen in course of operation during marked decreases in systolic pressure.

An additional factor in the decrease in plasma volume lies in the hyperventilation accompanying anesthesia with increased removal of water from the blood via the pulmonary aeration bed. This factor of increased insensible water loss probably continues throughout the period of anesthesia. Under nembutal anesthesia in normal dogs the plasma volume steadily decreases with prolongation of narcosis.[1]

Of interest is the apparent rapidity with which a falling volume may be augmented by an increase in the volume of circulating red cells. This phenomenon not only has the effect of aiding mechanical circulatory efficiency through volume restoration but also of increasing the oxygen carrying capacity of the blood in the face of a threatened anoxemia.

None of the cases studied during operation were in the condition known as "surgical shock," systolic pressure having been well maintained throughout. In Case 268 (Chart 3) a sharp fall in systolic pressure was accompanied by an *increase* in plasma and cell volume from levels obtaining during a previous period of higher blood pressure. The concurrent state of falling arterial tension and lowered blood volume was not consistently encountered in this study. This observation suggests that low tension "shock" need not necessarily be accompanied by a reduced total blood volume, at least in the initial stages.

[1] J. G. G. Unpublished observation.

There can be little doubt that the placing of patients in relatively high environmental temperatures during recovery, however advisable from other points of view, has the effect of lowering blood volume. This observation is in keeping with the findings of Gibson, Kopp and Evans (8) in the course of studies on blood volume changes during artificial fever, in which rapid and marked reductions in plasma volume occur during sweating. Since the output of the sweat glands is drawn directly from the blood stream, diaphoresis may deplete the circulating volume more rapidly than tissue fluid reserves can restore it. We regard these observations as serving to place further emphasis on the necessity of fluid administration during the period of immediate postoperative recovery.

The effect of postoperative intravenous administration of fluids was studied in only 2 cases in this series, and in both an apparently paradoxical response, namely, a decrease in total volume, was encountered, the decrease being accounted for by a withdrawal of red cells from circulation. We have observed that a similar decrease in red cell volume follows the rapid (30 cubic centimeters per minute) intravenous infusion of normal saline solution.

Similar observations have been made recently by Gilligan and Altschule following intravenous injections of isotonic or hypertonic salt solutions. Coller, Dick, and Maddock noted retention of water to the point of development of edema in patients receiving salt solutions intravenously. Our observations in these 2 cases offer an explanation of the formation of such edema. It should be emphasized, however, that both of these patients had sound hearts. It is possible that in patients with cardiac insufficiency, in whom the blood volume is already increased (7), administration of fluids intravenously might dangerously increase the total volume. It is suggested that hypertonic dextrose solutions are of greater usefulness in restoring depleted volumes than are normal saline solutions.

CONCLUSIONS

1. The plasma and total blood volume changes during anesthesia, operation, and recovery therefrom are described.

2. During anesthesia the decrease in plasma volume bears a direct relationship to the degree of elevation of blood pressure.

3. During operation fluctuations in the blood volume level vary with fluctuations in arterial tension, a rise in systolic pressure being accompanied by a fall in plasma volume, and vice versa.

4. The total volume is reduced at the end of operation, the reduction being due to a diminution of plasma volume, larger than can be offset by influx of red cells into the circulation.

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HEPATIC LESIONS OF THE NEWBORN

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LIVER damage in the newborn has seemed to occur more frequently in recent years, probably because of closer observation. While the present series of 69 cases is small, and taken entirely from the records of the New York Polyclinic Medical School and Hospital—covering a period of approximately 6 years—personal observation of similar lesions has been made in other hospitals. No particular significance was attached to the observations at the time. One lesion of the liver, characterized by fatty degeneration and early necrosis, has seemed to be of toxic type. It has occurred with sufficient frequency to justify a review of the clinical history to see what factors might have a bearing on its etiology.

The type of lesion found postmortem in the newborn, which has been most difficult to explain, has consisted of a distention of the hepatic cells with a fine deposit of lipoid, giving the cells a vacuolated and emulsified appearance. In addition, many of the cells have shown early necrosis, and the sinusoids have appeared almost obliterated. The lesion has seemed to commence most commonly in the central zone, although it may be distributed in patches throughout the lobule. As the lesion has progressed, the entire lobule has appeared affected, and the liver has been enlarged and has had a tense capsule. In the absence of marked congestion, the gross specimen has been of a definite yellow, or brownish-yellow, color. On section, the cut surface has at times been uniform and at other times mottled, depending upon whether the lesion was uniform, central, or patchy. This lesion is definitely different from the diffuse distribution of large fat droplets sometimes found in the livers of newborn laboratory animals.

It is believed that it is possible to recognize pathologically, with a reasonable degree of accuracy, those lesions resulting from prematurity, passive congestion, postmortem degeneration, simple fatty infiltration, syphilis, and antenatal arsphenamine poisoning. None account for the lesion described.

The premature liver. The premature liver is better developed, in so far as histological appearance is concerned, at an earlier date than many of the other organs. There is little difference between the premature liver and that of the full term newborn except that the blood islands are more numerous and larger, the liver cords thinner, the cells smaller, and the sinusoids correspondingly larger. The changes by which the liver lobules are subdivided into the permanent ones do not take place until after birth. The premature liver, after fifth month, is just as satisfactory for study as that of more mature newborn baby.

Passive congestion. Passive congestion in the newborn seldom resembles the picture described as chronic passive congestion for adults, unless the baby has lived for a considerable period and has also suffered from a definite cardiac lesion. The central lobular changes which are so characteristic of chronic passive congestion in adults are more the result of some secondary circulatory poison—probably absorbed from the gastro-intestinal tract—than from passive congestion *per se*. Anatomical factors in circulation practically prevent the development of such a lesion in the newborn. The passive congestive lesion in the newborn is usually nothing more than an engorgement of the sinusoids, sometimes a rupture of the central liver cords, and a moderate degree of cloudy swelling. Four cases of congenital cardiac defect with passive congestion are included in this series of cases. Any defect in the heart that would severely influence fetal circulation would be apt to lead to maceration and death *in utero*.

Postmortem degeneration. If the necropsy is performed within a reasonable time after death the gross changes will be slight. The histological changes will consist chiefly of

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cloudy swelling, followed by fragmentation and fraying of the cells. The cytoplasm may appear granular or amorphous. Nuclear changes follow with pycnosis, caryorrhexis, and caryolysis as autolysis is approached. Then the liver is totally unsuitable for satisfactory study. Fatty changes do not constitute a part of postmortem degeneration. *Hyperpyrexia* may hasten postmortem degenerative changes, as well as produce the earlier changes which are indistinguishable from postmortem degeneration. Congestion is usually pronounced in hyperpyrexia.

Simple fatty infiltration. Simple fatty infiltration is found to a mild degree in the very well nourished newborn; and to a more marked degree if there has been starvation due to any cause, either prenatal or postnatal. As a rule, the fat globules—usually single, and large—are scattered fairly well throughout the various lobular areas with no close relationship to the central zone. In those recently born suffering from intestinal obstruction, including blind pouch defects, congenital pyloric stenosis, peritonitis, meningitis, extreme hydrocephalus, or certain types of drug poisoning, the fatty infiltration may be marked. Simple fatty infiltration, alone, is unaccompanied by degenerative changes in the cells even when the droplet accumulation pushes the nucleus to one side.

Syphilis. Syphilis may occur as a pericellular cirrhosis, as a perilobular hepatitis with monocytic and lymphocytic infiltration in the portal canal areas, or as a patchy gummatous necrosis. The lesion is sufficiently inflammatory in appearance, even when necrosis is extensive, to suggest its cause. There is an associated osteochondritis of the long bones, and the small fibrous or better known large boggy placenta may suggest syphilis. Three cases in this series had evidence of syphilis.

Arsenical treatment. Prenatal arsenical treatment may occasionally induce toxic necrosis in the fetus, but such a condition should be readily recognized through both the history and the extensive necrotic lesion produced in the liver. It is a much more severe lesion than that described. Should such poisons as phosphorus, arsenic, mercury, or certain salts of most any of the heavy metals be taken by the mother; or such drugs as cinchophen, dinitrophenol, atophan, and others be taken by susceptible individuals, toxic necrosis might develop in the liver of either, or both, mother and child. This group of possible factors played no part, in the series of cases presented, in the production of hepatic damage.

Acute asphyxia. In simple acute asphyxia there is marked engorgement with great distention of the sinusoids, sometimes producing a rupture of the liver cords. Superimposed may be hemosiderosis, and accentuated postmortem degenerative changes. Acute asphyxia should be found in other organs as well. Pulmonary hemorrhage into the alveoli, extreme congestion of all viscera, subpleural and subepicardial petechiæ are common.

Partial asphyxia. Long continued partial asphyxia as the result of excessive maternal antepartum hemorrhage, continued partial strangulation, intracranial damage, excessive maternal exhaustion, massive placental infarction, and postnatal asphyxia should be recognized through the history and the postmortem examination.

Only one case is known to have had as a contributing factor excessive maternal antepartum hemorrhage. That patient was admitted with a maternal blood pressure of 50/30, and a diagnosis of placenta prævia. A stillborn baby was delivered by cesarean section, and its liver showed marked degeneration like that described. Another case is recorded in which the cord was around the neck of the child at the time of delivery. The total time of the second stage of labor, for that case, was 39½ hours; the baby was covered with meconium, and the liver damage was graded as severe. A third case showed maternal uterine inertia. Small doses of pituitrin were given and the baby, also with marked hepatic degeneration, was delivered 3½ hours later.

Intracranial damage is not believed to have played a large rôle in the causation of a secondary lesion in the liver, although it probably played a rôle in a few cases. The reason for the general denial of intracranial damage as a factor is because of the time element. Most, if not all, of the intracranial lesions occurred during the second stage of

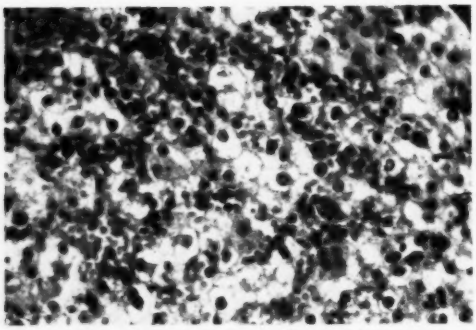

Fig. 1. Fatty degeneration and early necrosis in premature liver. Blood islands, numerous. Congestion, moderate.

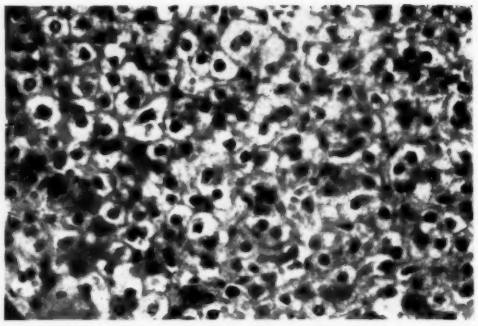

Fig. 2. A mature newborn liver showing rather uniform fatty degeneration and early necrosis.

labor. Most of the labor periods were short and in those dying immediately there would have been insufficient time between the moment the injury was sustained and the moment that death occurred for the lesion to have developed. Nevertheless, it is true that the greatest degree of liver damage was found with the highest frequency in the stillborn, and these same stillborn did show the highest incidence of intracranial damage. None of the stillbirths in this series show any record of having been anticipated clinically. Macerated fetuses have been excluded because of their unsuitability for study.

The factor of maternal exhaustion is a little more difficult to dispose of without some thought. A rough estimate of the degree of comparative exhaustion can be obtained from the average duration of labor (see Table I, sections 13, 14, and 15). Only 2 cases, in which patients showed marked hepatic degeneration, are recorded as showing any appreciable degree of maternal exhaustion (Table I, section 12). In 7 cases, distributed through the various gradings, patients received small doses of pituitrin or thymophysin; in 3 of these primary uterine inertia was given as the indication for the administration.

Since the placentas are not sent to the laboratory for routine examination it is impossible to state what percentage presented massive placental infarction. Insufficient data are available to be worth while. Judging from the lack of notation, it is believed that massive placental infarction did not play a prominent rôle.

After a study of all of the factors discussed, in only a few cases was a satisfactory explanation offered as to the etiology of hepatic degeneration in the newborn. Then, what other factors should be considered? Walters and Harris have suggested that opium derivatives, magnesium sulphate, barbituric acid derivatives, and avertin, reduce the minute-volume respiration with a resulting tendency toward asphyxia. Davis has placed animals under bell jars until anoxemia and asphyxia have occurred. In the livers of these animals he found marked fatty changes had taken place. He also found similar results following the use of certain types of anesthesia. Therefore it seemed advisable to investigate the clinical history to determine something about the anesthesia used and the preliminary medication given. The search proved interesting.

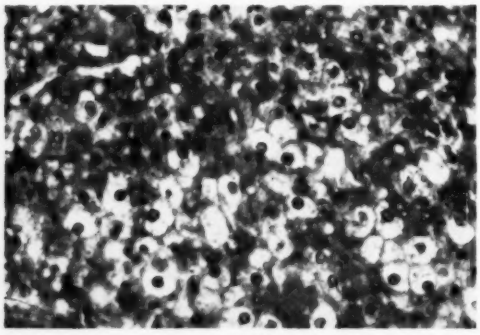

Fig. 3. Liver of mature full term baby showing patchy fatty degeneration with early necrosis.

In the cases presented the average amount of anesthetic administered was not great, and, except where rectal analgesia was used, the duration of the anesthesia was short (see Table I, section 11). It is perhaps advisable to say at this time that the lesions were graded prior to investigating the clinical history. It may be assumed, from the high percentage of difficult second stage procedures carried out, that the anesthesia was fairly deep. The fact that ether, gas-oxygen, and gas-oxygen-ether anesthesias were used would seem to make little difference, since any of them under suitable conditions might produce lesions similar to those described. Evidence of hepatic damage does not usually result immediately from anesthesia, but after a delayed period. Time is an element required for the development of a fatty degenerative lesion. Patients who die on the operating room table as the result of excessive anesthesia show little or nothing in their livers. At the end of a number of hours, if damage has been done, it may then be seen. Therefore, it seems that in view of the large percentage of these babies that died so soon after birth, the anesthetic proper administered by inhalation played little part in the production of the liver lesions. It also seems that the preliminary hypnotic medication, and rectal analgesia, played a more important rôle because of the longer period of action during the baby's life.

Rectal ether analgesia is probably capable of producing considerable liver damage, in certain instances. The mixture is absorbed and utilized for anesthesia over a variable but prolonged period of time. The ether must pass through the portal system of the mother, after absorption, to be eliminated chiefly through the respiratory tract. There is the added possibility that quinine may exert its properties in a mild manner as a protoplasmic poison. The average period elapsing between the administration of the rectal analgesia and delivery of the child was 7 hours, with one exception not here included—that was 75 hours.

Each of the derivatives of barbituric acid may have its clinical advantages as claimed (2). However, with reliable products it is believed that the effective dose is not as important, in the production of hepatic lesions,

TABLE I.—SUMMARY OF CASES

Cases are grouped according to the severity of the hepatic lesion found, into 1, 2, 3, and 4+.

Section		Severity of hepatic lesion					
		None	1+	2+	3+	4+	Totals
1	Mothers—primipara	16	4	7	4	12	43
	Mothers—multipara	10	3	2	5	6	26
2	Average age primipara	25	26	28	31	27	
	Average age multipara	30½	31	29	32½	30	
3	Males autopsied	13	2	5	3	8	31
	Females autopsied	13	5	4	6	10	38
4	Premature babies	14	2	4	2	6	28
	Full term babies	12	5	5	7	12	41
5	Spontaneous delivery	13	0	3	2	2	20
	Breech extractions	5	3	3	3	6	20
	Forceps used	7	4	3	2	7	23
	Cesarean section	1	0	0	2	3	6
6	Congenital cardiac lesions	2	0	1	0	1	4
7	Evidence of syphilis	2	0	0	1	0	3
8	Intracranial damage (hemorrhage, tentorial laceration, fracture skull or neck)	10	5	4	3	12	34
9	Stillborn or lived less than 30 minutes	4	3	5	2	12	26
	Lived less than 12 hrs.	11	1	0	2	4	18
	Lived less than 24 hrs.	2	0	2	0	0	4
	Lived from 2 to 13 days	9	3	2	5	2	21
10	Maternal toxemia	1	0	2	1	1	5
	Hypertension only sign. No toxemia	1	0	3	1	2	7
11	Average duration of anesthesia up to moment of delivery in minutes	17½	27*	20	29	28½	
12	Exhaustion recorded	0	0	0	0	2	2
	Received pituitrin or thymophysin, but not recorded as showing exhaustion	3	1	1	0	2	7
13	Average duration of labor, in hours	9	21	21½	21	19	
14	Cases with more than 12 hrs. of total labor	9	4	6	3	9	31
	Cases with less than 12 hrs. labor	17	3	3	6	9	38
15	Longest periods of labor for individual cases over 12 hrs.	72, 48, 34, 24, 22, 17, 14, 12, 12	72, 28, 24, 14	55, 48, 23, 17, 15, 13½	84, 72, 14	80, 53, 39, 34, 29, 20, 20, 19, 12	
16	Rectal analgesia	0	1	4	0	0	11
	Barbiturates given	4	5	3	5	9	20
	Received neither	22	1	2	4	3 ‡	32
	Totals	20	7	7	9	18	09

*One case of 3½ hrs. anesthesia not included.

‡One case showed maternal exhaustion; one case admitted as a placenta prævia with blood pressure of 50/30, delivered by cesarean section and stillborn; one case had pituitrin administered for failing uterine inertia, delivered 3½ hrs. later.

as the time that elapses between the administration of the drug and the birth of the child, plus individual susceptibility. "All barbitals act alike qualitatively, differing only quantitatively, so nothing is to be hoped for in the way of better and safer therapeutics from a barbital alleged to be effective in small dosage. . . . The efficiency varies directly with the toxicity. . . . The excretion of the barbitals is comparatively slow, and the drugs show a tendency to accumulate without complete destruction. . . . The drugs are also recognized as having some undesirable properties as general protoplasmic poisons" (3). In obstetrics, after the administration of barbiturates, it has been observed that the babies have a greater tendency to be apneic and require respiratory stimulation with comparative frequency. The action of the derivatives of barbituric acid is continued, at least for a short time, in the child after its birth.

In the series presented, the preliminary medication was often administered prior to the onset of true labor. The average dose of sodium amytal was 6 grains; nembutal 4½, and 9 grains in 1 instance; and luminal dosage varied from 1½ grains to a total dosage of 28½ grains in one instance. The average period of time elapsing between the administration of the drugs to the mother and the delivery of the child was as follows: sodium amytal, 17 hours; nembutal, 32 hours; luminal, 26 hours, with 3 exceptions not included which averaged 134 hours.

From the preceding discussion it may be seen readily that no positive conclusions can be drawn from this series of cases, nor any similar series of cases based on clinical and pathological evidence, primarily because of the multiplicity of factors involved.

Sixty-nine newborn infants were subjected to necropsy and showed livers suitable for study. Nearly every case, except 2, presented a definite cause for death which was sufficient to exclude liver damage as the chief cause. Many of the babies were prematurely born (see Table I, section 4). A large number were born by difficult breech extractions with the aid of forceps (see Table I, section 5). A high percentage presented evidence of intracranial damage such as hemorrhage, tentorial laceration, or other evidence of injury in the region of the head (Table I, section 8). Eight of these showed definite fractures of the skull; 2 occipitoparietal osteodiastasis; and 3 a fractured neck.

By reviewing section 16 of Table I it may be observed that of the 26 cases showing no evidence of hepatic damage only 4 received preliminary hypnotics. Of the correspondingly opposite group, showing marked hepatic damage, there were 18 cases. Fifteen of these had preliminary medication of some sort. It will also be noted that for this latter group the average length of life after birth was the shortest of any group. (Table I, section 9). Twelve of the 18 babies lived less than 30 minutes. Actually, 10 were stillborn. The longest anesthetic given to any in this group was 45 minutes, with an average of 28½ minutes (Table I, section 11).

The purpose of this article has not been to suggest that the use of barbitals is entirely undesirable. It is not believed that the hepatic lesions described could have done more than add to the embarrassment, and certainly many cases must recover without evidence of hepatic damage when there is no other primary factor to produce death. The only suggestion that can be drawn with reasonable safety is, the derivatives of barbituric acid and rectal ether analgesia when administered to the mother are not completely without toxic action on the fetus. If these drugs are used judiciously, they ought to give satisfaction. Should their toxic action be disregarded, they will be found to exert an embarrassing detrimental effect on too many occasions.

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ACUTE OSTEOMYELITIS OF THE UPPER END OF THE FEMUR

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CHANGES in bone similar to those caused by osteomyelitis have been found in the remains of prehistoric animals. The head and neck of the femur of a giant wolf found in a pleistocene deposit in California showed changes resembling those which result from a "septic hip" infection as seen in a child today (28). Evidence of osteomyelitis has been seen in prehistoric human bones unearthed in caves and burial grounds of Europe, Asia, Northern Africa (6), and North America (20). Egyptian mummies have shown destruction of the mandible resulting presumably from infection (38). The Hippocratic school recognized the bone infection which followed compound fractures and endeavored to prevent and to treat it.

Throughout the dark ages little was added to the knowledge of osteomyelitis until the fourteenth century when John Ardenne advocated the removal of sequestra, and Scultetus, in 1634, is said to have been the first to resect the shaft of a long bone for infection (47). In 1705, J. L. Petit described an acute disease of the long bones which we now recognize as acute osteomyelitis, and Nélaton, in 1834, suggested that the term osteomyelitis be used to designate infection of bone (40). Pasteur, in 1878, isolated the Staphylococcus aureus which he considered the cause of a "furuncle of bone," and, in 1884, the same organism was shown by Becker to be the usual causative agent of acute bone infection.

It remained for Lexer, in 1896, to elucidate the pathology of acute hematogenous osteomyelitis by producing the disease in rabbits. Meanwhile, Senn, in 1895, had observed clinically the primary focus in the metaphysis and was among the first to advocate early drainage of this area as the treatment of choice in acute osteomyelitis. During the twentieth century advances have been made in the treatment of the systemic infection, and there has been a more widespread acceptance of the principles of drainage of the infected bone as advocated by Senn, Lexer, and Starr.

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ANATOMICAL CONSIDERATIONS

A knowledge of the anatomy of the upper part of the femur and the hip is necessary to an understanding of the course followed by infections in this region. The changes in the location of the epiphyseal lines of the upper femur throughout infancy and adolescence are shown by the roentgenographic tracings in Figure 1. The epiphyseal line of the head of the femur is partially intracapsular at birth and becomes entirely intracapsular when the child is 2 or 3 years old. Throughout the period of growth the epiphyseal line of the greater trochanter is in close juxtaposition to the capsule of the hip joint on the upper anterior aspect of the femoral neck (10), while the epiphysis of the lesser trochanter is at some distance from the hip joint. Because of the proximity of the joint, infections of the femoral neck arising in the metaphysis opposite the capital epiphysis or the epiphysis of the greater trochanter frequently give rise to a pyarthrosis of the hip.

The blood supply of the upper end of the femur (Fig. 2) throughout the period of bone growth is derived in large part from the superior branch of the nutrient artery, as was well shown by Lexer and his associates. These observers also described the vessels which penetrate the periosteum and enter the cancellous bone of the upper end of the femur, as well as the branches of the medial and lateral femoral circumflex arteries which pass through the capsule of the hip joint and course along the neck beneath the synovial reflection to join the vascular bed at the capital epiphyseal line. The vessels in the round ligament, which have long been recognized, have recently been

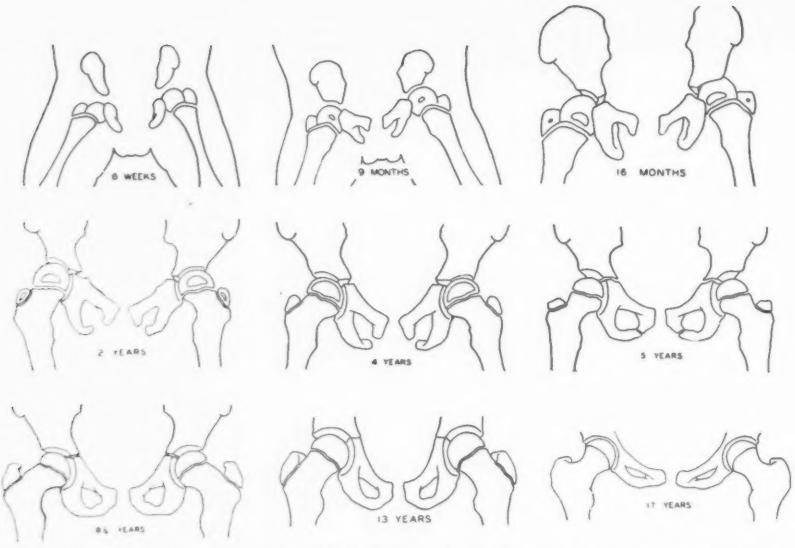

Fig. 1. Tracings of roentgenograms showing the epiphyseal lines of the upper end of the femur. The capital epiphysis lies within the capsule of the hip joint after 2 years of age, and the epiphyseal line of the greater trochanter is in close juxtaposition to the capsule of the hip joint.

restudied and are considered by some observers (17, 50) to be of major importance in the nutrition of the capital epiphysis during the period of growth, while others (42, 46) attribute some of this function to arteries which penetrate to the head from the epiphyseal line.

The transition in the vascular tree from the relatively narrow caliber of the nutrient artery to the wide circulatory bed of the capillaries is attended by a slowing of the blood stream at the epiphyseal line. As the capillary buds grow upward into the epiphysis they form diverticulous vascular pouches in which the capillary circulation is even more markedly slowed (31). Thus, any trauma sufficient to damage the capillary wall in this region may well lead to the stagnation of the local circulation, the lessening of the local resistance, and the creation of a favorable site for the development of infection from organisms in the blood stream.

The lymph drainage from the upper end of the femur ascends through the deep lymphatic trunks to reach the iliac lymph glands (17). From the hip joint the lymph drains by way of the deep system into the deep femoral and iliac lymph glands (18). It should be noted that there are no direct trunks from the upper femur or hip to the inguinal lymph glands and that the latter do not become enlarged or tender in cases of infection of the upper femur, or hip joint, until late in the course of the disease, if they are affected at all.

PATHOLOGICAL CONSIDERATIONS

The present conception of the early bone changes in acute hematogenous osteomyelitis is in large measure derived from experimental reproduction of the disease in rabbits. Rosenbach was among the first to produce experimental hematogenous infection of bone by injecting organisms into the blood stream and fracturing the tibia; however, it remained for Lexer to produce in rabbits a disease comparable in virtually every respect to the acute hematogenous osteomyelitis of man. By injecting Staphylococcus pyogenes aureus into the veins of young rabbits, he obtained early foci in the metaphysis adjacent to the epiphyseal line. He also demonstrated the spread of infection along the epiphyseal line to give

rise to subperiosteal abscesses, and where the epiphyseal line was largely intracapsular as at the hip, showed direct extension of pus into the joint cavity as a result of rupture through the synovia from the lesion at the epiphyseal line[1] (Fig. 3). The marrow cavity was thought to be involved by progression of the infection through the cancellous bone of the metaphysis; recently, however, this extension is believed to occur more often from the subperiosteal region *via* the haversian canals (45). Late in the acute stage of the disease soft tissue abscesses from the spontaneous rupture of a subperiosteal abscess or of a pyarthrosis of the hip may occur. The series of pathological changes observed in the experimental animal has been seen repeatedly in the acute hematogenous osteomyelitis of man.

The microscopic picture of the early focus is that of a minute abscess in which the organisms can often be seen. While the inflammatory reaction is confined to the metaphyseal side of the epiphyseal line, organisms have been found extending up into the adjacent epiphysis (36), and at times the infection penetrates directly through the epiphyseal cartilage into the joint. As the lesion spreads, thrombosis may contribute to the bone necrosis caused primarily by the infection (47). Although it is beyond the scope of this paper to consider chronic osteomyelitis, the frequency of separation of the capital epiphysis of the femur late in the course of acute infections of the femoral neck should be noted. In long standing infections of the hip joint with attendant relaxation and destruction of the capsule, there is also a tendency for the head of the femur to become dislocated. Unless preventive steps are taken, secondary infection of the hip often results in destruction of the epiphyseal cartilage (33) and eventual ankylosis of the hip. Following damage to the capital epiphysis there is often a disturbance of the growth of the femur which results usually in shortening of the leg although at times lengthening may occur.

[1]In our experimental laboratory a virulent culture of hemolytic Staphylococcus aureus was injected into the nutrient artery of the femur in 36 immature rabbits. Seventeen of these animals developed either gross or microscopic bone lesions. The most frequent site was the lower end of the femur, though in 7 the upper end of the femur was involved. In one of these a pyarthrosis of the hip also occurred. Eight cases of pyarthrosis of the knee were found and in several of these the spread into the joint from abscesses along the epiphyseal line could be demonstrated.

The systemic effect of the disease and the complications which not infrequently develop from the co-existent blood stream infection are of equal importance to the bone focus. Although the toxemia which forms so prominent a part of the clinical picture is due to the presence of the infection (8, 16), the patient's resistance may be lowered by the development of dehydration and acidosis. Metastatic abscesses may occur in any organ but are most frequent in other bones, in the kidneys, and in the lungs.[2]

CLINICAL CONSIDERATIONS[3]

Between 1930 and 1936, 21 patients with acute hematogenous osteomyelitis of the upper end of the femur were admitted to the wards of the Duke Hospital. In this survey the children with mild or low grade infections, and those with acute transient symptoms, have not been included. With few exceptions a complete follow-up study has been made of each patient at intervals of every 12 months or less and efforts have been directed toward obtaining an accurate clinical and x-ray record of the disease in the individual case. These patients have been of particular interest because they present a difficult problem in diagnosis and in treatment. The observations which follow are recorded not in the conviction that the therapeutic method chosen has always been correct, but in the hope that by comparing our results with others, which have been and will be reported, a satisfactory method of treating this very difficult infection may be reached.

Six of the patients studied were infants; these cases are analyzed in Table I. This arbitrary separation of the problems presented in infants from those presented in older children is made because acute osteomyelitis in infancy calls for different therapeutic procedures (11), and is usually followed by less permanent disability. Fifteen patients between the ages of 3 and 16 years (Table II)

[2]Of the 11 children admitted to the Duke Hospital during the past 5 years with acute osteomyelitis who died and upon whom autopsies were performed, 8 showed pneumonias or pulmonary abscesses which were thought to be due to the organisms of the osteomyelitis; 7 showed renal lesions; 6 showed cardiac lesions, and there were 4 with metastatic bone lesions. In none of these cases was the vascular thrombosis described by Wilensky observed.

[3]We wish to thank Dr. Deryl Hart and Dr. A. R. Shands, Jr., for permission to follow and report these cases.

TABLE I.—ACUTE OSTEOMYELITIS OF THE UPPER END OF THE FEMUR IN INFANTS LESS THAN 2 YEARS OF AGE

History No. Age, months Sex	Duration of symptoms prior to operation, days	Foci of infection Trauma T. (on admission) White blood count	Blood culture	Operation	Traction Cast	Culture from femur or hip	Length of follow-up	End-result
12127 20 Male	6	Upper respiratory infection—varicella Fall 39.4 degrees C. 20,000	Staphylococcus aureus	Drainage of subperiosteal abscess upper end of femur	T	Staphylococcus aureus	Died 4 days after operation	Died. No autopsy
13916 11 Male	21	Erysipelas None 39.6 degrees C. 14,200	Beta, hemolytic streptococcus	Drainage of pyarthrosis hip	T followed by C, 4 mo.	Beta, hemolytic streptococcus	5 months	Sinus healed, hip mobile, no shortening; x-ray, decalcification of neck of femur
15565 12 Male	13	Upper respiratory infection None 41 degrees C. 15,400	Staphylococcus aureus	Drainage of pyarthrosis hip	T followed by C	Staphylococcus aureus	2 months	Sinus healed, hip mobile, no shortening, no x-ray
19631 19 Male	24	Upper respiratory infection None 39.6 degrees C. 25,800	No growth	Drainage of soft tissue abscess of thigh	T	Staphylococcus aureus	Died 8 days after operation	Died. Autopsy, acute osteomyelitis of the upper end of the femur; very early abscesses in the kidneys, the lungs, and the liver
27219 12 Female	15	Upper respiratory infection None 38 degrees C. 37,100	Bacillus Influenza	Drainage of soft tissue about hip joint	T	Bacillus Influenza	Died 15 days after operation	Died. Autopsy, acute osteomyelitis of the neck of the femur, purulent arthritis, hip purulent meningitis, lobular pneumonia
78733 10 Female	28	Upper respiratory infection None 38 degrees C. 24,000	Not taken	Drainage of pyarthrosis hip	T, 2 mo.	Staphylococcus aureus	Under treatment at present	2 months after onset treated by traction at home; sinus healed; x-ray, destruction of neck of femur

were seen and form the subject matter for this report.

DIAGNOSIS

It is difficult to make a diagnosis of acute osteomyelitis of the upper end of the femur in the early stages of the illness. The infection originates in a bone covered by a large muscle mass; the child often is unable to localize his pain to a small area and may refer it to the general region of the hip, the thigh, or the knee. The examiner frequently cannot demonstrate tenderness limited to the bone, and he may find it very difficult to eliminate the numerous disorders which simulate primary involvement of the upper end of the femur. Moreover, the clinical picture of a lesion which begins in the metaphysis of the neck and is complicated by early infection of the hip joint differs from that presented by the patient with a primary focus in the metaphysis opposite the greater or lesser trochanter, which does not extend to cause a pyarthrosis of the hip. Also, the formation of a soft tissue abscess from extension of a subperiosteal or hip joint infection may still further alter the features of the case. To determine accurately the status of a given patient, it is not only necessary to make a diagnosis of osteomyelitis of the upper femur but it is also important to know the exact site of the primary focus and its subsequent extension.

The symptoms and signs presented by an acute osteomyelitis developing on the metaphyseal side of the capital epiphyseal plate of the femur are well illustrated by the following case.

W. E. (No. 71223), a white boy 13 years of age, was admitted to the Duke Hospital on August 6, 1936, complaining of pain in the left thigh. Six days previously he had noticed a furuncle on the inner aspect of the left thigh, and 2 days later he had a chill and developed severe pain in the left thigh. For 4 days prior to entry he remained in bed with an elevated temperature of 103 to 104 degrees F., and complained constantly of pain in the left thigh and hip, although he could move the hip without adding greatly to his discomfort.

Physical examination on admission revealed an acutely ill white boy with a temperature of 39.8

degrees C. (103.5 degrees F.), a pulse of 110, and respiration of 22. He complained bitterly of pain in the left groin which radiated down the thigh to the inner aspect of the knee. There was a healing furuncle on the medial aspect of the left midthigh and another on the dorsum of the right wrist. There were numerous dental cavities, the pharynx was injected, and the tonsils were enlarged and inflamed. Deep pressure elicited tenderness over the neck of the left femur in Scarpa's triangle; however, there was little if any tenderness over the trochanter or the neck of the femur posteriorly. The left hip could be moved through an almost normal range of motion when the maneuver was performed slowly. The patient was as comfortable when the thigh was extended as when it was flexed.

Studies of the blood showed: hemoglobin, 100 per cent; white blood count, 8,400. Differential: polymorphonuclears, 85 per cent (segmented, 58 per cent; stab, 26; J-forms, 1 per cent). The urine examination was negative and a blood culture taken on admission showed after 48 hours a growth of hemolytic Staphylococcus aureus. Roentgenograms of the pelvis and femora showed no bone abnormality.

A tentative diagnosis of acute osteomyelitis of the upper end of the left femur was made and skin traction was applied to the patient's left leg to await localizing signs before resorting to operation. This conservative measure (a transfusion was given also and fluids were forced) resulted in some relief of his pain; the temperature, however, remained elevated and the blood picture did not change. Three days after admission he suddenly began to complain of more severe pain in the hip and asked for the traction to be removed as he felt more comfortable with the left thigh flexed. Examination at this time showed tenderness on pressure over the neck of the left femur anteriorly in Scarpa's triangle, and marked tenderness on pressure over the trochanter as well. When the traction was removed he held the left thigh flexed, abducted, and slightly externally rotated. The muscles about the hip joint were spastic and any attempt to move the left thigh at the hip caused marked pain and voluntary resistance.

At this time roentgenograms of the pelvis and femora were negative and the leucocyte count was 9,000. A diagnosis of pyarthrosis of the left hip secondary to extension of a primary focus at the capital epiphyseal line was made, and the patient was operated upon at once. The hip joint was found to be filled with thick yellow pus (from which hemolytic Staphylococcus aureus was cultured), and on the inferior aspect of the neck of the femur at the capital epiphyseal line a sinus could be seen where an abscess in the metaphysis beneath had perforated the synovia to infect the joint (Fig. 4).

The close similarity in the clinical picture between a primary infection at the capital epiphyseal line and a lesion which originates at the epiphyseal line of the greater trochanter makes it virtually impossible to differentiate clinically between the two in their early stages. Even after following such cases carefully over a period of years with roentgenograms at frequent intervals, one may be unable to determine which area is the site of the primary focus. A pyarthrosis of the hip may follow an infection originating either in the metaphysis opposite the capital epiphysis, or in that opposite the greater trochanter. The following case is an illustration of an acute osteomyelitis which from the available clinical and roentgenographic evidence started in the metaphysis opposite the greater trochanter and caused a secondary pyarthrosis of the hip.

B. S. (No. 8106), a white boy 9 years of age, was admitted to the Duke Hospital on September 30, 1931, with the complaint of severe pain in the upper right thigh which radiated to the inner aspect of the right knee. One week previously he had seemed listless and had had a dry cough. Two days later he first noted an aching pain in the right thigh which grew progressively more severe, and at this time he developed a temperature of 103 degrees to 104 degrees F. which remained elevated until admission. For 2 days he limped about the house, but for the 48 hours immediately before entry he had remained in bed with the right thigh flexed.

Physical examination revealed an acutely ill white boy with a temperature of 40 degrees C. (104 degrees F.), a pulse of 122, and respiration of 26. The tonsils were large and red, the pharynx was injected, and the cervical lymph nodes were enlarged. He preferred to lie on his back with his right thigh flexed at the hip and slightly abducted. Any attempt to move the thigh passively encountered resistance and caused marked pain referred to the lower part of the thigh and the knee. There was tenderness over the entire upper thigh, greatest over the lateral aspect of the femur immediately below the greater trochanter.

Studies of the blood showed: hemoglobin, 75 per cent; white blood count, 9,900. Differential: polymorphonuclears, 81 per cent. The urine examination was negative but on a blood culture taken on admission there was a growth of Staphylococcus aureus within 24 hours. Roentgenograms of the pelvis and femora were negative. On aspiration of the right hip joint a small amount of turbid fluid was obtained which was negative for organisms on examination of a stained smear but which showed later a growth of Staphylococcus aureus.

A diagnosis of acute osteomyelitis of the upper end of the femur was made, and at operation, after the bone was exposed, perforator openings were made at the point of maximal tenderness below the greater trochanter. A pocket of necrotic bone and

TABLE II.—ACUTE OSTEOMYELITIS OF THE UPPER END OF THE FEMUR IN CHILDREN OVER 2 YEARS OF AGE

History No. Age, years Sex	Duration of symptoms prior to operation, days	Foci of infection Trauma T. White blood count	Blood culture	Operation	Traction Cast	Culture from femur or hip	Length of follow-up, years	End-result
6802 6 Male	21	None demonstrable None 39.2 degrees C 10,500	Not taken	None	T, 2 mo. C, 2½ mo.	Not taken	5	Walks with limp, 1½ inches shortening; no motion at hip; x-ray, bony ankylosis
16505 14 Male	11	Tonsillitis Blow over hip 39.6 degrees C 18,400	Staphylococcus aureus	None	T, 1 mo. C, 5 mo.	Aspiration of hip, Staphylococcus aureus	3	Recurrence of acute symptoms 2 years after original infection; at present infection quiescent; walks with limp, 1½ inches shortening; slight motion at hip; x-ray, destruction capital epiphysis
17062 8 Female	11	Pansinusitis None 39.6 degrees C. 33,400	Staphylococcus aureus	None	T, 1 mo. C, 3 mo.	Not taken	5	Walks with marked limp; ankylosis of hip; dislocation of head of opposite femur
1252 14 Female	3	None demonstrable None 40.8 degrees C. 28,000	Not taken	Drilling neck of femur; pus encountered; necrotic bone drained	T, 1 wk. C, 2 mo.	Staphylococcus aureus	5	Walks without limp; 1 inch shortening excellent motion at hip joint; x-ray, destruction capital epiphysis
2254 14 Female	4	Upper respiratory infection Fall on hip 39.6 degrees C. 18,500	Staphylococcus aureus	Drilling neck of femur; pus encountered; necrotic bone drained	T, 4 mo. C, none	Staphylococcus aureus	6	Walks with slight limp on built-up sole, 1½ inches shortening; good motion at hip; x-ray partial destruction of capital epiphysis and shortening of neck of femur
8106 9 Male	10	Upper respiratory infection Fall on hip 40 degrees C. 9,900	Staphylococcus aureus	Drilling of cancellous bone below trochanter; necrotic bone drained	T, 2½ mo. C, 2 mo.	Staphylococcus aureus	5½	Walks without limp, no shortening; excellent motion at hip; x-ray, areas of old bone destruction of intertrochanteric region and neck
17537 9 Male	5	None demonstrable Fall on hip 40.3 degrees C. 16,000	Hemolytic staphylococcus aureus	Drilling neck of femur; pus encountered; area of necrotic bone drained	T, 2 mo. C, 3 mo.	Hemolytic Staphylococcus aureus	4½	Chronic invalid due to chronic osteomyelitis; multiple bone involvement including the upper ends of both femora with ankylosis of both hips
21686 3 Male	8	Furunculosis Fall on hip 39.8 degrees C. 17,800	Staphylococcus aureus	Drainage subperiosteal abscess about upper end of femur; drilling femur below trochanter	T none C, 4½ mo.	Staphylococcus aureus	4	Walks with limp, 1 inch shortening; fair motion at hip; x-ray, destruction of capital epiphysis
7488 16 Female	28	None demonstrable None 38.2 degrees C. 11,000	Not taken	Drainage subperiosteal abscess about upper end of femur; drilling femur below trochanter	T, 3 wk. C, 3 mo.	Hemolytic Staphylococcus aureus	5	Walks with slight limp, 1 inch shortening; fair motion at hip; x-ray, partial destruction capital epiphysis and neck of femur
53916 7 Male	10	None demonstrable Blow on thigh 40 degrees C. 17,380	Hemolytic staphylococcus aureus	Drainage subperiosteal abscess about upper end of femur	T, 10 da. C, none	Hemolytic Staphylococcus aureus	2	Walks without limp, no shortening; excellent motion at hip; x-ray, old destruction intertrochanteric region
54853 12 Male	9	Upper respiratory infection Fall on hip 39.4 degrees C. 22,200	Hemolytic staphylococcus aureus	Drainage subperiosteal abscess about upper end of femur	T, none C, 4 mo	Hemolytic Staphylococcus aureus	1½	Walks with crutches, good functional results without shortening and good motion at hip first affected and drained early; upper end of opposite femur developed osteomyelitis; drained late with resultant stiff hip on opposite side
45325 16 Male	30	No focus demonstrable Strained hip 39.4 degrees C. 27,000	Hemolytic staphylococcus aureus	Drainage subperiosteal and massive soft tissue abscess about upper end of femur	T, 18 da. C, none	Hemolytic Staphylococcus aureus	Died	Died 18 days after admission and operation; no autopsy, clinical evidence of staphylococcal pneumonia and pyelonephritis
44789 6 Male	28	None demonstrable Fall on thigh 39 degrees C. 13,600	Not taken	Drainage pyarthrosis hip joint; drilling neck of femur	T, none C, 8 mo.	Hemolytic Staphylococcus aureus	2	Walks, with limp, 1 inch shortening, hip ankylosed; x-ray, destruction of capital epiphysis
54800 9 Female	8	No focus demonstrable Fall on thigh 40.4 degrees C. 17,000	Hemolytic staphylococcus aureus	Drainage pyarthrosis hip joint	T, 3½ wk. C, 6 mo.	Hemolytic Staphylococcus aureus	1½	Walks with marked limp, 1 inch shortening; poor motion at hip; chronic osteomyelitis upper end of femur
71223 13 Male	8	Furunculosis None 40.3 degrees C. 8,400	Hemolytic staphylococcus aureus	Drainage pyarthrosis hip joint	T, 6 wk. C, 9 mo.	Hemolytic Staphylococcus aureus	1	Under treatment at present; chronic osteomyelitis of upper end of femur

pus was encountered and the hip joint was not drained. Following operation the child's temperature, which had been elevated, gradually fell and remained normal after 10 days. The leg was kept in extension by means of skin traction for 2½ months, and this was followed by the application of a plaster hip spica for 3½ months. When this was removed 6 months after the onset of the infection, the incision had healed, and the patient has had no subsequent recurrence over a period of 5½ years.

The roentgenograms made every week during the 82 days the patient was in the hospital showed an area of bone destruction about the metaphyseal side of the greater trochanter 3 weeks after the onset of symptoms. The bone destruction spread up toward the capital epiphysis; however, there was never any extensive involvement of the capital epiphyseal line whereas there was extensive decalcification (destruction) of the metaphysis opposite the greater trochanter (Fig. 5). As the primary changes in the bone were above the operative drill hole the latter was not considered responsible for the progressive bone destruction. With healing there was no growth disturbance.

In the preceding case little fluid was obtained on aspiration of the hip, and the joint was not drained at operation. None the less, cultures of the fluid later showed a growth of Staphylococcus aureus, and subsequent roentgenograms have demonstrated some destruction of the articular surfaces of the hip joint. The patient belongs to the group of infections which originate in the metaphysis opposite the greater trochanter, cause varying degrees of destruction of the femoral neck, and give rise to a secondary pyarthrosis of the hip by extension through the adjacent synovia.

In contrast to the lesions which cause secondary involvement of the hip, as illustrated by the preceding cases, is that group of primary foci which originate in the metaphyses of the greater and lesser trochanter and do not extend to infect the hip joint. Osteomyelitis arising at any point in the upper femur may, of course, involve the entire neck and invade the hip joint; however, if the lesion is recognized early, adequate drainage may prevent joint extension and thus lessen the possibility of a subsequent ankylosis. The following case is one of that group in which the primary focus may occur in the metaphysis of the greater or lesser trochanter and is not followed by secondary joint infection.

G. C. (No. 53916), a white boy 7 years of age, was admitted to Duke Hospital on June 13, 1935, with the complaint of pain in the right thigh and fever which had been present for 5 days. The pain had been maximal just below the greater trochanter and had become progressively more severe. He had been unable to walk since the onset. Having been seen by his family physician during the epidemic of poliomyelitis, he was admitted with the diagnosis of poliomyelitis.

Physical examination revealed an acutely ill white boy with a temperature of 40 degrees C. (104 degrees F.), a pulse of 130, and respiration of 26. The patient was lying flat in bed and was shielding his right thigh against any pressure. After his confidence had been gained he could be persuaded to move his thigh through a fair range of motion without pain, and there was no muscle spasm about the hip. The single consistent positive finding was marked tenderness over the upper third of the thigh, maximal on the lateral aspect below the greater trochanter.

Studies of the blood showed: hemoglobin, 72 per cent; white blood count, 9,000. Differential: polymorphonuclears, 88 per cent. Examination of the urine was negative. A blood culture taken on admission showed a growth of hemolytic Staphylococcus aureus after 48 hours. Roentgenograms of the pelvis and femora were negative and the spinal fluid was normal. On aspiration of the hip no fluid was obtained.

A diagnosis of acute osteomyelitis of the upper femur was made, and at operation, on incision of the subcutaneous tissue at the point of greatest tenderness below the trochanter, a subperiosteal abscess was encountered and drained. Subsequent roentgenograms showed an area of bone destruction in the metaphysis opposite the greater trochanter which extended into the intertrochanteric region. One month after operation the incision had healed, and 8 months later there was roentgenographic evidence of satisfactory healing of the bone in the diseased area (Fig. 6). In this case the infection in the cancellous bone decompressed itself by the formation of a subperiosteal abscess and at operation the area of necrotic cortex through which the pus had made its way was easily removed with the thumb forceps.

Taken as a group, children who have a severe osteomyelitis of the upper end of the femur (as contrasted with the mild type of infection) have an acute onset with pain in the general region of the hip or thigh which often radiates to the medial aspect of the knee. There may be a history of antecedent injury of the extremity, and a respiratory infection, a furuncle, an infected laceration, or varicella pustule may suggest the probable source of the bacteriemia which precedes the bone involvement. Occasionally there is a prodromal period characterized by malaise and general lassitude, and a chill may usher in the acute

illness. An elevation of temperature is noticed near the time the pain becomes severe. Although the child may limp for a few hours after the onset of symptoms, the pain becomes more severe and he soon goes to bed and resents and resists any attempt to move him or his painful limb. The appetite is lost, vomiting is not infrequent, and in infants diarrhea and convulsions are not uncommon.

Examination early in the illness may reveal a fretful, ill child who cannot localize his pain but who complains when the crib is jarred or when any attempt is made to touch or move the affected thigh. The temperature is elevated as a rule to between 38.8 degrees C. (102 degrees F.) and 41 degrees C. (106 degrees F.). After gaining the patient's cooperation, it may be possible to determine that there is definite tenderness over the neck of the femur in Scarpa's triangle, or medially or posteriorly or over the lateral aspect below the trochanter. Repeated efforts to locate a definite area of tenderness should be continued, in so far as the patient's condition will permit, until the examiner is convinced that his observations are accurate. Later in the course of the disease there is spasm of the muscles about the hip, and as the joint becomes involved the thigh is held flexed, abducted, and slightly externally rotated. Any attempt to move the limb from this position causes pain and is resisted by the patient. Even at this time there is seldom any swelling of the region affected. When, however, a large subperiosteal abscess has formed or a soft tissue abscess has developed from extension of a pyarthrosis of the hip, then swelling of the thigh and buttock is the rule. For effectual treatment the clinical diagnosis should be made long before this stage is reached.

Laboratory procedures, while of assistance, cannot supplant accurate clinical observation. The leucocyte count usually is elevated, ranging from 10,000 to 30,000 white blood cells, but in a severe infection it may be low with an abnormally high proportion of non-segmented cells (16). Routine examination of the urine as a rule is negative; however, the test for lipuria (Hedri's sign) (13) should be made, and if it is found positive it is of significance. The roentgenograms of the pelvis and femora show no evidence of bone destruction until 2 weeks or more after the onset of symptoms; however, when the hip is involved secondarily, widening of the joint space is visible before the appearance of bone changes. A procedure of great aid in making the diagnosis, and at the same time in determining the extent of the infection, is aspiration of the hip joint; this should be carried out on all patients who are suspected of having acute osteomyelitis of the upper end of the femur. A needle of large caliber (No. 18) is introduced under local anesthesia along the anterior surface of the neck of the femur until the joint space is entered, and the aspirate may be studied by a stained smear and by culture. If frank pus is obtained, or if organisms are present on the smear, there is infection of the joint and the severity of the involvement may be gauged by the type of exudate present.

On the other hand, the absence of purulent fluid in the hip joint does not rule out acute osteomyelitis of the upper end of the femur, as cases without hip joint infection frequently occur. Nor does the presence of a pyarthrosis of the hip always point to a primary lesion in the femur, although this should be considered probable until it is proved to the contrary. A number of disorders closely simulate acute osteomyelitis of the femur and must be eliminated before a differential diagnosis can be made.

DIFFERENTIAL DIAGNOSIS

Primary pyarthrosis of the hip. Purulent arthritis of the hip due to the pneumococcus and to the gonococcus is of common occurrence and most frequently develops as a complication of an acute infection due to these organisms elsewhere in the body. A primary synovial infection of the hip joint by the streptococcus may not be rare; however, a pyarthrosis due to the Staphylococcus aureus is most often secondary to a focus in adjacent bone (5, 35). Hence, if pneumococci, gonococci, or streptococci are found in the fluid aspirated from the hip, the diagnosis of a primary joint infection may be considered probable. One reservation should be made with regard to the pyarthrosis caused by the

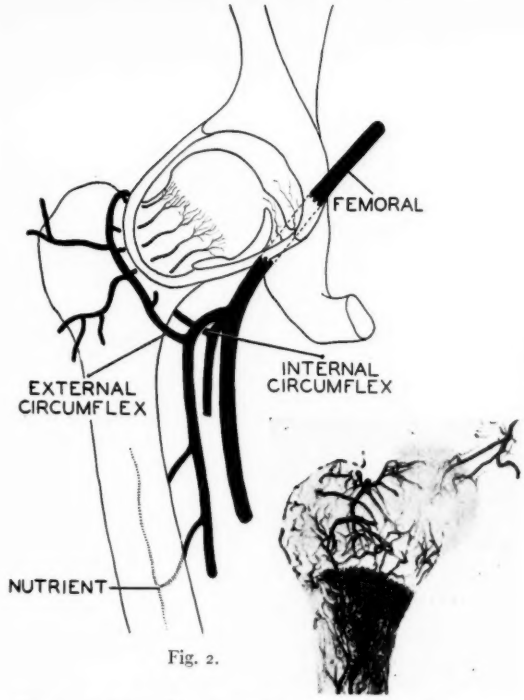

Fig. 2.

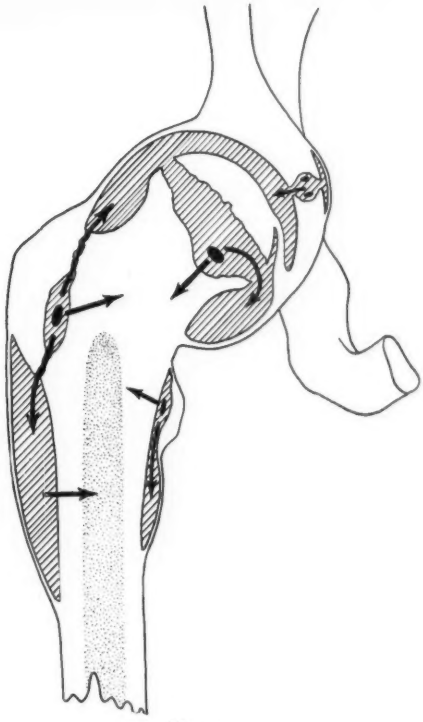

Fig. 3.

Fig. 2. a, left. Diagrammatic representation of the major arterial blood supply of the upper end of the femur in an adolescent child (from dissection). The anastomosis between the branches of the internal and the external femoral circumflex arteries which encircle the neck of the femur provide a good source of blood supply to the epiphyseal line by branches which penetrate the capsule and lie along the neck of the femur beneath the synovia. b, The vascular bed at the epiphyseal line of the upper end of the femur in an infant (after Lexer). The nutrient artery is a main source of blood supply for the epiphyseal vascular bed. Secondary sources are branches from the periosteal circulation and vessels which run in the round ligament.

Fig. 3. A diagrammatic representation of the possible routes of extension of infections arising at different points in the metaphyses at the upper end of the femur.

Fig. 4. W. E. (No. 71223). Exposure, at operation, of the neck of the femur and of the capital epiphyseal line when draining a pyarthrosis of the hip secondary to an acute osteomyelitis of the upper end of the femur showing the point of rupture of the abscess in the metaphysis which had opened into the joint to cause the pyarthrosis.

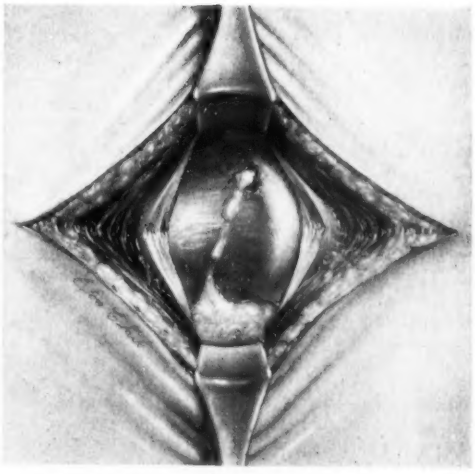

Fig. 4.

streptococcus, as a certain proportion of these purulent hip joints are also secondary to an acute osteomyelitis in adjacent bone. However, the streptococcus infections of the hip are well considered as one group, for when the diagnosis of joint involvement is made early, and the patients are treated by joint drainage

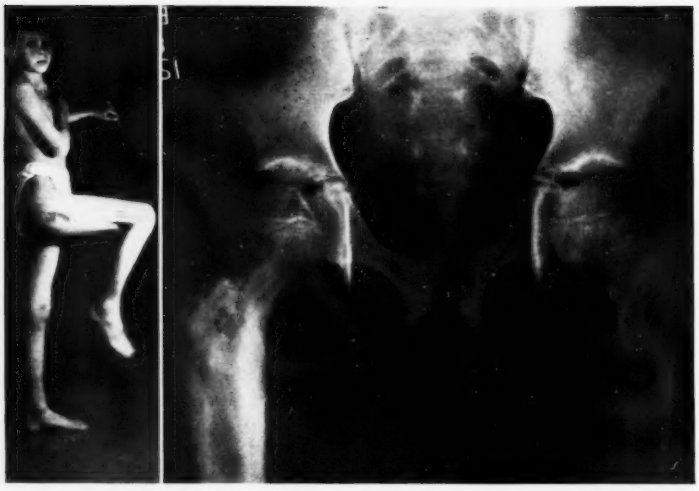

Fig. 5. B. S. (No. 8106). a, left. The patient 5½ years after an acute staphylococcus osteomyelitis of the upper end of the right femur complicated by a pyarthrosis of the hip. Drainage was provided by drilling the neck of the femur. b, Roentgenogram of the patient's pelvis 5½ years after the acute infection showing the well preserved capital epiphysis with evidence of old bone destruction in the metaphysis opposite the greater trochanter. The patient has a normal range of motion in the hip.

and traction, the bone lesion decompresses itself into the joint and there is little bone destruction and subsequent disability (30). In the following case a primary streptococcal lesion of the neck of the femur drained spontaneously and was not treated by traction until 7 weeks after the onset of the infection, yet a mobile hip joint was obtained in spite of extensive joint involvement.

B. S. (No. 21751), a white girl 7 years of age, was admitted to the Duke Hospital on January 31, 1933. Following an attack of otitis media she had suddenly developed severe pain in the left hip 7 weeks before admission. For 2 weeks the pain in the hip, which at times radiated to the left knee, persisted and her temperature of 102 to 104 degrees F. remained elevated. A blood culture at this time showed a growth of hemolytic streptococcus. Forty-eight hours after the onset of the pain she kept her thigh flexed and resisted any attempt to move it. Three and one-half weeks after the onset of her illness an abscess in the soft tissue about the hip drained spontaneously. The child kept the hip flexed and was brought to the hospital 7 weeks after the onset of acute symptoms because of her inability to extend the thigh.

Examination revealed a pale, ill-looking, emaciated white girl 7 years of age. The left hip was held flexed at 45 degrees, slightly abducted, and internally rotated. Any attempt at manipulation caused her to cry with pain. Posterior to the greater trochanter, over the buttock, were scars of sinuses through which the abscess about the hip had drained spontaneously.

Studies of the blood showed: hemoglobin, 74 per cent; white blood count, 14,000. Examination of the urine was negative. Roentgenograms of the pelvis and femora showed a destructive process in the neck of the left femur with epiphyseal separation and upward displacement of the shaft.

The epiphyseal separation was reduced by traction, and after reduction the hip was immobilized in a plaster spica cast for 6 weeks. For 6 months thereafter the patient used crutches. At the present time, 4 years after her illness, she walks with a limp and has 2 centimeters of shortening of the left leg which can be corrected with a built-up sole. There is a satisfactory range of motion at the hip joint although the roentgenograms show absorption of the capital epiphysis and that the metaphysis of the neck of the femur articulates with the acetabulum (Fig. 7).

A streptococcal infection at the capital metaphysis of the femur followed by a pyarthrosis of the hip is a not uncommon complication of otitis media in children (47, a). Purulent arthritis due to the streptococcus is best treated by early drainage of the joint (15, 43), traction, and subsequent immobilization if necessary. Occasionally in the less severe

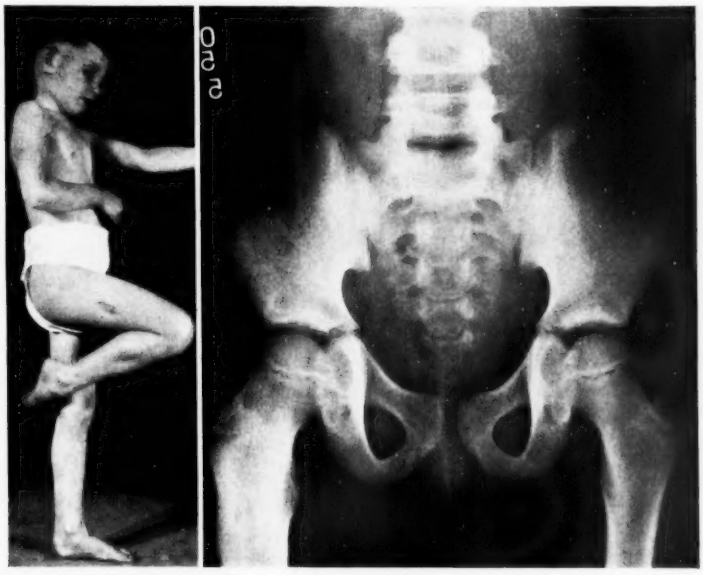

Fig. 6. G. C. (No. 53916). a, left. The patient 2 years after an acute staphylococcus osteomyelitis of the upper end of the right femur. The primary focus in the metaphysis of the neck of the femur opposite the greater trochanter extended to form a subperiosteal abscess which was subsequently drained. The hip was not involved by the infection and there is normal motion in the joint. b, Roentgenogram of the patient's pelvis taken 2 years after the acute infection showing a normal capital epiphysis with evidence of healed osteomyelitis in the intertrochanteric region.

cases good results may be obtained by traction alone (47, a).

As the clinical picture of an acute pyarthrosis of the hip is so similar to that of an acute osteomyelitis of the upper end of the femur, the differential diagnosis between the two often depends on the information obtained on aspiration of the joint. At times it may be necessary to follow the patient over a period of months before the final opinion is reached. In this connection it is important to note that a primary synovial infection may show no bone destruction over a period of months except as a result of pressure after the articular surfaces have been damaged by the infection. The following case of primary pneumococcus arthritis of the hip illustrates the absence of bone destruction in the presence of a hip joint infection of long standing.

L. H. (No. 50081), a colored infant, was brought to the Duke Hospital on November 13, 1935, with the complaint of swelling of the left thigh for 3 weeks, developing shortly after an attack of pneumonia. The mother thought the patient had "some fever" throughout her illness.

On examination the temperature was 39.5 degrees C. (103 degrees F.). The left thigh and buttock were swollen, hot, and tender. Any attempt to move the left leg caused the baby to cry out with pain.

Studies of the blood showed: hemoglobin 75 per cent; white blood count, 18,600. Differential: polymorphonuclears, 78 per cent. The urine examination was negative. Roentgenograms showed widening of the left hip with dislocation of the head of the femur above the acetabulum. Aspiration of the hip joint yielded thick green pus from which pneumococcus type IV was cultured.

The soft tissue abscess was drained, and at operation an opening into the hip joint was demonstrated. Roentgenograms at frequent intervals over a period of 9 months after the acute illness have failed to reveal any area of destruction in the head or neck of the femur, and the capital epiphysis remained intact although attempts to keep the head in the acetabulum have been unsuccessful (Fig. 8, a).

Acute osteomyelitis of the innominate bone and ilium. Five patients with primary acute osteomyelitis of the ilium have been seen dur-

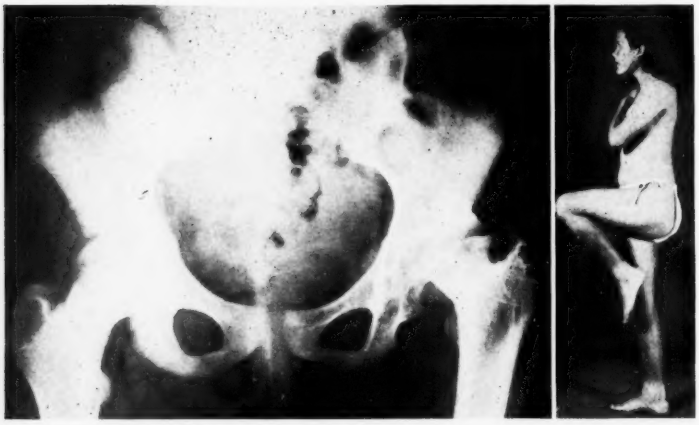

Fig. 7. B. S. (No. 21751). a, left. Roentgenogram of the patient's pelvis showing the destruction of the capital epiphysis of the left femur, and the neck articulating with the acetabulum 4 years after an acute streptococcus osteomyelitis of the upper end of the femur. b, The patient has a normal range of motion in the hip except for limitation of abduction.

ing the past 6 years. Four of these suffered from the acute diffuse type (27) of the disease with destruction of the acetabulum and involvement of the hip joint. In no case was the diagnosis made until the region of the hip joint was exposed at operation or until there was roentgenographic evidence of bone destruction. In reviewing the histories of our patients and of reported cases (2, 3, 41, 49) no significant difference was found in the symptoms presented by a patient with an acute process in the neck of the femur and one with a primary focus in the acetabular portion of the ilium. The finding, on physical examination, of an abscess in the internal iliac fossa, or of marked tenderness over the inner table of the ilium on rectal examination, has suggested the diagnosis of acute osteomyelitis of the ilium. At times tenderness has been demonstrated over the external table of the ilium, and asymmetrical muscle spasm about the hip (19) or limitation of extension with retention of mobility at the hip joint (2) has suggested the presence of an iliac lesion. When, as in 3 of our patients, the hip joint was involved, however, the physical findings were so similar to those of acute osteomyelitis with secondary joint extension that the differential diagnosis was made only after there was roentgenographic evidence of bone destruction in the ilium. Of some importance is the fact that acute osteomyelitis of the upper end of the femur is six times as frequent as a primary infection of the ilium.

Acute osteomyelitis of the ischium and pubis. Although the majority of the cases of osteomyelitis of the ischium and the pubis are subacute, and the patients frequently develop a pelvic, perineal, or inguinal abscess before they reach the surgeon, occasionally a fulminating infection of the acetabular portion of the ischium or the pubis will be seen. Thus, the usual patient with osteomyelitis of the pubis may complain of pain over the pubic ramus. The 3 patients with subacute osteomyelitis of the ischium who were seen during the period covered by this study had pain and tenderness about the upper medial portion of the thigh and perineal floor. In such cases a mass may be demonstrated arising from, or attached to, the pubis or the ischium. In contrast to this group, however, is the fulminating infection originating in the acetabular portion of the ischium or pubis. Such a case was a 10 year old boy whose symptoms and signs so closely simulated those of acute osteomyelitis of the upper end of the femur that a differential diagnosis was not made until operation.

Fig. 8. a, left. L. H. (No. 50081). Roentgenogram of the pelvis of a 2½ year old child 18 months after an acute pyarthrosis of the left hip due to pneumococcus type IV. In spite of dislocation of the head of the femur there has not been complete destruction of the capital epiphysis and fragmentation of this structure is only recently beginning. b, B. G. M. (No. 78733). Roentgenogram of the pelvis of a 10 months old infant which was taken 3 months after a pyarthrosis of the right hip due to the Staphylococcus aureus (and probably secondary to an acute osteomyelitis of the neck of the femur) showing early destruction of the capital epiphysis which is characteristic of the staphylococcus hip infections secondary to a primary focus in the neck of the femur.

B. McI. (No. 66002), a white boy 10 years of age, was admitted to the hospital on April 20, 1936, complaining of pain in the left thigh which radiated to the knee. For the 3 days since onset he had been in bed, unable to walk, and had an elevated temperature of 103 to 104 degrees F.

Physical examination showed an acutely ill white boy 10 years of age lying in bed with the left thigh flexed and slightly externally rotated. The left thigh was diffusely swollen with points of maximal tenderness present over the greater trochanter and the lateral aspect of the midthigh. Any attempt to move the extremity caused severe pain.

Studies of the blood showed: hemoglobin, 85 per cent; white blood count, 12,900. Differential: polymorphonuclears, 91 per cent. Examination of the urine was negative, and a blood culture taken on admission showed a growth of hemolytic Staphylococcus aureus 24 hours later. Roentgenograms of the pelvis and femora were negative.

A tentative diagnosis of pyarthrosis of the left hip secondary to an adjacent osteomyelitis was made and the hip joint was aspirated without obtaining any fluid. The neck of the femur was then explored without locating a focus of infection, and cultures of the bloody serum from the bone later showed no growth. The child was returned to the ward and after skin traction was applied to the left leg he was given hemolytic Staphylococcus antitoxin and a blood transfusion.

In spite of these measures the temperature remained elevated to between 40 and 41 degrees C. (104 to 106 degrees F.) and the child failed to improve. He continued to have pain in the general region of the hip and no new area of local tenderness could be elicited. It was thought advisable to explore the acetabular rim, and 48 hours after admission a second operation was done. At this time perforator openings were made in the margin of the acetabulum, and on the second attempt, anteriorly and above the neck of the femur, a pocket of pus was encountered and drained. The patient's convalescence thereafter was satisfactory, and 2 weeks later there was roentgenographic evidence of bone destruction in the acetabular portion of the pubis (Fig. 9). Subsequently this infection involved the hip joint; however, extensive bone destruction was limited to the acetabular portion of the pubis. The same clinical picture, and complication, could have been presented by an acute osteomyelitis of the acetabular portion of the ischium.[1]

Acute transient infections of the hip. This group is composed of patients with pain in the hip, an elevation of temperature, and an increase in the number of leucocytes. The onset

[1]Since these cases were studied a 15 year old girl (No. 82346) with an acute infection about the hip joint has been seen. First diagnosed as an acute osteomyelitis of the upper femur, the subsequent course of events demonstrated the original lesion to be in the ischium. Drainage of the hip joint was followed by subsidence of the acute infection.

Fig. 9. B. McI. (No. 66002). Roentgenogram of the pelvis showing early evidence of bone destruction in the pubis of a patient with symptoms and signs suggesting acute osteomyelitis of the upper end of the femur. Exploration of the femur on admission failed to expose the focus of infection. However, prompt improvement followed drainage of the upper margin of the acetabulum at a second operation 2 days later.

of the condition usually is acute, and while the child may walk painfully with a limp for a short time, he is soon more comfortable in bed with the thigh flexed. There are varying degrees of tenderness over the trochanter and the neck of the femur anteriorly and posteriorly. Movement of the thigh may cause pain but this is not so great as that present in a case of pyarthrosis of the hip, and there is less muscle spasm about the joint than in the latter disorder. Aspiration of the hip joint usually yields negative findings. Treatment by means of skin traction applied to the affected extremity, plus general supportive measures, usually affords rapid relief of symptoms. The pain becomes less and less severe, and over a period of from 1 to 2 weeks the temperature falls to normal. Should the symptoms fluctuate in intensity and should multiple joint involvement supervene, a diagnosis of acute rheumatic fever would suggest itself. If, within 48 to 72 hours, the conservative therapy has not brought about great improvement in patient's symptoms and signs, they will likely be found to be due to a more permanent lesion than an acute transient infection.

Subacute infections about the hip joint. This group of inflammatory lesions of the upper end of the femur, hip joint, and pelvis are characterized by a more gradual onset, milder local symptoms, and less constitutional reaction than is the case in acute osteomyelitis. This difference in the severity of the symptoms and signs allows the physician more time to form an opinion as to the nature of the infection. The same diagnostic measures may be indicated as are applicable in the cases of acute infection, yet the subacute case may be treated conservatively without anxiety, at least for a time, while one awaits changes in the x-ray photograph or the development of a localized subperiosteal or soft tissue abscess. However, even in this group of patients the hip joint should be aspirated, as the information obtained helps to establish the diagnosis. Occasionally in the subacute infections it is impossible to differentiate between a pyogenic and a tuberculous lesion until a biopsy is done.

At times it may be necessary to exclude acute poliomyelitis, acute appendicitis, or acute metastatic psoas abscess (44) before a diagnosis of acute osteomyelitis of the upper end of the femur can be made. Elimination of such injuries as separation of the femoral epiphysis or dislocation of the hip may be indicated, and Legg-Perthes' disease occasionally may need to be ruled out. In all cases suggesting these diseases a careful study, including the usual diagnostic procedures, will enable a differential diagnosis to be made without great difficulty.

TREATMENT

A most important factor in the treatment of acute osteomyelitis of the femur is the time which elapses between the onset of symptoms and the establishment of the diagnosis (1, 26, 30, 44). Moreover, early diagnosis is important in securing a good end-result not only in those patients with acute bone lesions, but also in those with either primary or secondary pyarthroses of the hip. Nevertheless the need for careful determination of the patient's physical status, and adequate preparation for any operative procedure contemplated, is as great in this group of infections as in any acute surgical condition. During the period of observation which in many instances is necessary, the essential

studies may be done, the original impression confirmed by re-examination, and the patient's condition improved by the administration of fluids. The toxemia may be combated by a transfusion and the use of antisera (16), and the patient's pain frequently may be relieved by the application of skin traction to the extremity affected.

In most instances the history and physical examination alone will indicate a focus of infection in the region of the hip. The accessory examinations should include a study of the blood with a white blood count and a differential leucocyte count. Even in a severe toxemia the total number of white blood cells may be low, but the differential count with an increase in the proportion of nonsegmented leucocytes may aid in gauging the toxemia. The urine, which should be examined especially for a lipuria (13), may give confirmatory evidence of a primary bone lesion. A routine blood culture on entry is indicated in every case suspected of having acute hematogenous osteomyelitis. The presence of a Staphylococcus aureus blood stream infection demonstrable within 24 hours after admission may add considerable weight to the clinical impression of a primary bone focus. Little assistance can be derived from the roentgenograms until 2 weeks after the onset of acute symptoms, and frequently more than 3 weeks elapse before there is definite evidence of bone destruction. When the hip is involved there may be widening of the joint space at a relatively earlier date.

Aspiration of the hip should be carried out on every patient who presents symptoms and signs that suggest the presence of an acute pyogenic infection in the region of the joint, and if fluid is obtained it should be studied by a stained smear and by culture. If examination of the stained smear is negative for organisms, a growth may appear on the culture after 24 hours. By this means the group of synovial infections due to the pneumococcus and gonococcus and those due to the streptococcus may be differentiated from the Staphylococcus aureus pyarthrosis, which is secondary to a focus in adjacent bone. Should pneumococci or streptococci be demonstrated on aspiration of the hip, prompt open drainage

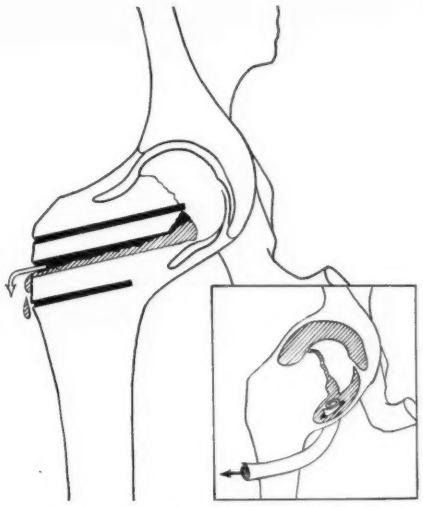

Fig. 10. a, left. Operative treatment of acute osteomyelitis of the upper end of the femur. Drill holes are made up through the neck to the capital epiphyseal line as represented. If pus is encountered the drill hole is enlarged with a perforator, or if the abscess is superficial the cortical bone is removed with a rongeur until adequate drainage is obtained. b, If a frank pyarthrosis of the hip is present, a rolled up strip of Penrose tubing is used to drain the joint.

of the joint with the application of skin traction to the affected extremity may be the treatment of choice. In addition to the usual supportive measures, antisera, immune transfusions (23), and sulfanilamide (27) may be of benefit. In our experience, unless traction is used in connection with other measures in hip joint infections due to the gonococcus, destruction of the articular cartilage occurs and is followed by ankylosis of the hip.

Should no fluid be obtained on aspiration of the hip, and if there is any question of the infection being acute and severe, it may be wise to apply skin traction to the leg and watch the child for 24 hours. At the end of this period the blood culture may show growth; better localizing signs may be present, and during this time it may be possible to improve the patient's general condition by the administration of fluids, a transfusion, or the use of antiserum (16). Lack of improvement at the end of this time or a positive blood culture of Staphylococcus aureus points to a primary focus, most probably in the neck of

the femur. In the type of problem herein described and in the case with well defined localizing signs which can be diagnosed when first seen as an acute osteomyelitis of the upper end of the femur, the upper femur should be explored as soon as the patient's general condition warrants. Although some (14) have advised the creation of a large opening through the neck of the femur, we think that exploratory drill holes through the neck and cancellous bone below it will serve to demonstrate any pocket of infection present, and, when gross pus is encountered, the small hole can be enlarged with a perforator (Fig. 10). The method used for drilling the femoral neck provides for exploration of the metaphyseal area while disturbing as little as possible the blood supply of the epiphyses and the epiphyseal line (Fig. 2). Should no gross infection be demonstrated, the operator is faced with the problem of exploring the acetabular margin or of awaiting the results of the cultures of the bloody fluid from the drill holes in the femur. At this point it may be wise to confirm the previous hip joint findings by direct aspiration of the joint through the capsule exposed on the posterior aspect of the neck of the femur.

The decision regarding exploration of the margin of the acetabulum should be made on the merits of the individual case. We have failed to find a lesion in the neck of the femur or in the hip and have returned the patient to the ward only to explore the acetabulum 48 hours later when the patient failed to improve and when cultures from the femur were negative. In other instances it may be wiser to proceed and explore the acetabulum at the initial operation. Once a focus of infection is found it should be opened sufficiently wide with a perforator to relieve pressure and allow adequate subsequent drainage. Especial operative procedures for treating acute infections of the ilium (2), ischium, and pubis (24) have been reported.

If, on aspiration of the hip joint, Staphylococcus aureus is found, the joint infection is, very probably, secondary to a focus in adjacent bone, and the problem arises whether to drain the upper femur, or the hip joint, or both. Drainage of the hip under these conditions has been advanced as the procedure of choice (5, 15, 29, 34, 36, 43, 44) but there are no enthusiastic reports of the results obtained in the Staphylococcus aureus infections. Drilling the neck of the femur has its advocates (1, 14, 30) and under certain conditions others advise draining the joint and drilling the femur as well (12, 34). From the short series herewith reported (Table II) no didactic statement of the optimum method can be made; however, we believe that if the patient's pain is not relieved by hip joint drainage, or if the signs of toxemia persist, the neck of the femur should be explored also.

In this series of cases the patients who were seen and operated upon within the first 2 weeks after the onset of the acute symptoms showed less permanent disability and a lower mortality than those who came to treatment after that time. We have not obtained satisfactory results in the patients in whom drainage of the hip joint was done; however, our experience with this procedure has been limited. We are now draining the hip joint in all cases of joint involvement and hope at a future date to report our added experience.

The best results are obtained in those patients with acute osteomyelitis of the upper end of the femur whose symptoms are recognized and treated by drainage of the bone focus before secondary involvement of the hip joint occurs.

Following operation, skin traction should be applied to the affected extremity and the thigh should be kept in a partially abducted and slightly flexed position. In older children the limb may be suspended in a Thomas splint with a Pearson attachment and the patient may be encouraged to move the leg. Should the toxemia persist following operation, repeated transfusions (39) and the administration of staphylococcus antitoxin (16) have proved most beneficial. A positive blood stream infection after adequate drainage of a lesion about one hip may suggest the presence of a metastatic focus, possibly in the upper end of the opposite femur as occurred in 2 of our cases.

The progress of bone destruction may be followed best by roentgenograms of the pelvis and the upper end of the femur at intervals of from 7 to 10 days during the first 6 weeks of

the illness. The duration of the maintenance of traction must be determined individually in each case; however, when the hip joint is affected, traction should be continued for 6 weeks or longer. If the capital epiphysis should begin to separate or the head of the femur to dislocate, a plaster hip spica may be applied, keeping the patient's thigh abducted, slightly flexed, and slightly internally rotated. Immobilization in plaster following the use of traction usually is necessary in the majority of cases and should be maintained until there is good evidence of healing. Crutches, with or without a walking splint, may be used for several weeks before the patient is allowed to bear weight on the affected leg. Throughout this period efforts should be made to increase the mobility at the hip. Should shortening of the leg occur, a built-up (cork) sole may help correct a limp.

SUMMARY

1. A résumé of the historical, anatomical, and pathological aspects of acute osteomyelitis of the upper end of the femur is presented.

2. Twenty-one cases of acute osteomyelitis of the upper end of the femur are reported, of which 6 occurred in infants and 15 in children over 2 years of age.

3. The differential diagnosis is discussed and the value of aspiration of the hip joint as an aid in making the diagnosis is emphasized.

4. From the authors' experience they conclude that the treatment of choice in cases of acute osteomyelitis of the upper femur due to Staphylococcus aureus is early diagnosis and drainage of the bone lesion.

5. Supportive measures including antiserum and repeated transfusions are of value.

6. During the postoperative period traction followed by immobilization in a hip spica until there is evidence of bone healing has been found to give best results.

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SOME SURGICAL ASPECTS OF TUBERCULOUS DISEASE OF THE ABDOMINAL LYMPHATIC GLANDS

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AN INVESTIGATION into the preoperative histories and postoperative results in 239 consecutive cases of caseous and calcareous abdominal lymphatic glands has brought together many points of interest. The patients were admitted into one of the wards of the Aberdeen Royal Infirmary during the 10 year period 1923 to 1932 and may be classified as follows:

TABLE I

Nature of case	Traced or dead	Untraced	Males	Females	Totals
Caseous cases	36	2	21	17	38
Calcareous cases	144	22	91	75	166
Re-operation cases	31	4	15	20	35
Totals	211	28	127	112	239

The ward only exceptionally received patients under 12 years of age as these were referred to the Hospital for Sick Children. The ages of the 38 patients with the caseous type of the disease was considerably less than in the calcareous type. Apart from two of 36 and 52 years, they were under 29 years of age, and yielded an average of approximately 21 years with a median of 18½. Of 201 patients operated on for the calcareous type of the disease the average was just over 25 years of age and the median 23. Ten of the 38 patients with caseous glands, or more than a quarter, were between 11 and 15 years. This differs from Braithwaite's findings that:

> Between the ages of 10 and 15 years there appears to be a period when the disease is not commonly evident.

It is possible that different ages of admission to hospital in different localities may explain this. Twenty-eight of the patients were resident in towns and 10 came from the country districts.

Relative proportion of human and bovine bacilli. Golden and Reeves state that viable tubercle bacilli are not demonstrated in the majority of their cases of calcified nodes examined by routine methods, but that occasionally the guinea pig test is positive. They do not say whether the human or the bovine type of bacilli were found. In Edinburgh, Wang found that 9 of 10 cases of alimentary tuberculosis were due to the bovine strain of tubercle bacillus. Hart and Rabinowitsch in Germany obtained cultures from 6 cases of primary intestinal and mesenteric gland tuberculosis and found that 5 were bovine. Topley and Wilson divide the abdominal cases into 2 types: primary and secondary. They write:

> Primary abdominal tuberculosis is almost invariably due to the bovine type; but secondary abdominal tuberculosis, which occurs most frequently as a late complication of pulmonary tuberculosis is generally due to the human type.

Blacklock (3) found in 94 necropsies of children with primary lung tuberculosis, that all the infections were with the human type of bacillus, but that in 64 with primary abdominal tuberculosis, 54 (81.8 per cent) were infected with the bovine type. Apart from the 10 cases with actual or suspected pulmonary tuberculosis, and even in some of these, it may be assumed that most of the 239 cases were due to the bovine type of bacillus from infected milk.

Portal of infection (lesion of the gut). Still points out that in children there is very frequently tuberculous ulceration of the intestinal wall:

> Probably even in the mildest cases and in the earliest stage of tabes mesenterica, there is some tuberculous ulceration in nearly all cases. My own figures made whilst I was pathologist at the Children's Hospital shewed that of 132 cases with tu-

berculous enlargement of the mesenteric glands, 107, that is, over 80 per cent shewed ulceration of the bowel.

He goes on to say that this ulceration should give bacilli in the stools and that bacteriological examination sometimes yields conclusive proof of the presence of tuberculosis. Again:

> The frequency of abdominal tuberculosis, therefore, although it is a matter chiefly of pathological observation, has a practical significance as a manifestation of the tendency to rapid and wide dissemination of tubercle in a child.

In only one of our cases was an examination of the stools made for tubercle bacilli and it was negative.

Blacklock (loc. cit.) writes:

> Primary tuberculous lesions were found in the abdomen in 82 (3.9 per cent) of the 2,126 cases under three, and in 41 (11.0 per cent) of 374 over this age, ... As regards the type of primary lesions in this series, it was found that intestinal ulceration with caseation of the mesenteric glands occurred in 22 instances. All these cases were fatal and the majority occurred in cases under 3. In the remaining 101 cases, though the mesenteric glands were tuberculous, no naked-eye evidence of intestinal ulceration was noted.

Apart from the various external constrictions produced in the bowel by the development of peritoneal adhesions, we found no evidence of the development of strictures of the gut itself, i.e., strictures resulting from the healing of tuberculous ulcers of the mucosa. It must be assumed, therefore, that in the patients who survive, the bacilli have reached the glands without producing any permanent gross lesion of the bowel. Many others have noticed this and experimental evidence supports it. Lymphatic spread from elsewhere is out of the question in most of these cases. Presumably the tubercle bacilli either pass through the gut without producing any demonstrable lesion in it or such lesion heals well. Similarly glandular tuberculosis in the neck may arise with no apparent (tonsillar) lesion.

The appendix was the only part of the gut examined on its internal surface and also microscopically. It may be endowed with a special degree of resistance by its lymphoid tissue. Small lesions of the ileum might have escaped detection. There was only one case of tuberculosis of the ileum during the 10 years under review. It has not been included in the series.

> The patient was a male (aged 2 years), who died from emaciation and pyrexia 8 months after a resection of a diseased ileum. The glands were very extensively affected with tuberculosis both in the caseous and calcareous stages.

Cases of cecal tuberculosis are not rare, but none was seen in this series. Healed lesions of the cecum and especially of the right colon would be difficult to exclude unless they were indurated. Lesions of the lower ileum are easily detected. It is not supposed that there was no initial bowel lesion, but no lesion was detected at operation.

The atrophic appendix. An atrophic appendix was suggested by Corner in 1505 as possible evidence of a healed primary lesion. He had operated on a male (aged 41 years), and found an atrophic appendix and a caseous mass the size of a walnut. Commenting on this he wrote:

> The case just related illustrates the co-existence of an atrophic appendix and a large caseous gland in the mesentery of the small intestine. It is possible that they represent indirectly the primary and secondary effects of the same disease. The tuberculous lesion in the intestine may have left no other mark behind it than the atrophic appendix.

This relationship does not seem to be borne out by facts. It would be expected that, in an occasional case at least, signs of active tuberculosis would be found in the appendix, as is found in from 5 per cent (Howarth and Gloyne) to 35 per cent (Mitchell) of tonsils. Out of the 93 appendices examined microscopically from patients who had caseous and calcareous mesenteric glands, *only one possibly tuberculous appendix* was found and this was doubtful. Many atrophic appendices also are found without any sign of abdominal tuberculosis. An arresting fact is that the atrophy begins distally and commonly results in obliteration of the lumen there.

It is possible that if the atrophic appendix represents the end-results of old tuberculous appendicitis, of which fact no serial evidence has yet been published as far as we know, the bacilli are absorbed directly into the lym-

phatic system during the acute or subacute inflammatory stage. Later no sign of tuberculosis of the appendix itself is demonstrable. Alternatively recurrent attacks of non-tuberculous, appendicular inflammation stimulate glands already tuberculous to become caseous, and later on they calcify. Appendicular inflammation is associated with caseation in about half the number (Colt and Clark, 11). This view of the matter is new as far as we know, and seems to fit the facts better than the suggestion first made by Corner. The absence of tuberculous lesions in the appendix supports it and also the fact that a distally atrophic appendix, or an appendix showing signs of chronic inflammation, is found in such a large proportion of calcareous gland cases. Of 172 cases of caseous and calcareous mesenteric glands in this series, where the condition of the appendix has been noted, 112 showed either atrophic or chronic appendicitis, a percentage of 65, which is very remarkable. Of these 19 were of the atrophic type and probably there were many more included in the chronic variety but were not specifically noted as such.

Theories of calcification. Klotz's theory of calcification whereby the fat in the caseous material is broken up and forms calcium soap to be replaced later by calcium phosphate and carbonate is generally accepted. There is about nine times as much phosphate as carbonate. The tendency to calcification would appear to be more marked in the abdomen than elsewhere in the body, but the cause of this is not clear. In the commonest situation for chronic tuberculosis, viz., the lungs, calcification seldom occurs. The hilar glands are frequently affected with tuberculosis, and in children they often caseate, yet x-ray examination seldom shows calcification. The difficulties of examination of the chest as compared with the abdomen must be taken into account. At postmortem examination calcification is not seen with any great frequency and when present is small in amount. Muir writes:

> In our experience, however, a subpleural healed or calcified nodule in some part of the lung other than the apex is relatively rare, as are also calcified bronchial glands.

Blacklock's (2) observations support this. Assuming Klotz's theory to be correct, an explanation of the frequent occurrence of the calcification in the mesenteric glands lies in the fact that they are likely to have a greater intermittent supply of fat than the other glands of the body. The fat after absorption has to traverse the glands before it reaches the receptaculum chyli and is perhaps broken up in the process. Yet another possibility is that as the glands are in the portal circulation, the venous blood influences the process. Its composition must be different from that in the general circulation after the excretion of the alkaline succus entericus and the absorption of acid substances from the bowel. This would fit in with the theory of Wells who criticizes Klotz's theory and suggests that calcification depends on physicochemical processes rather than on chemical reactions alone; calcium being present in the blood almost at saturation point and being held in solution by the colloids and carbon dioxide. In the region of dead tissues, where the tension of carbon dioxide is low, the blood is liable to deposit some of its contained calcium.

Rate of calcification. We are still largely ignorant of the rate at which calcification occurs. Caseation must take place first and from the study of cervical adenitis it would seem to be a very early process. Bruce, writing on tuberculous neck glands, makes the statement:

> Ninety-nine per cent of all glands which have persisted for three months and have attained the size of a hazel nut shew signs of caseation when removed by dissection.

As caseation may occur without giving rise to any, or very few, and trivial symptoms the average length of histories is no real guide. Even if it were, there is the possibility that appendicular pain would confuse the issue. When the appendix is found to be normal at operation, we are perhaps justified in some cases in assuming that the glands alone, cause the pain. In some of the cases under review, mesenteric glands were found in process of calcification. Two such cases are the following:

> A female patient, aged 18 years, had had generalized abdominal pain on and off for a year, in

monthly attacks. The pain settled later in the right iliac fossa and was unrelated to the periods. It was felt also in the vagina and leg. The appendix was normal. The x-ray showed the glands so clearly that calcification must have been fairly advanced.

A male, aged 29 years, who had suffered for 6 months from attacks of pain in the right iliac fossa had at operation caseous glands. These showed up on the x-ray films and the microscopic examination showed them to be calcified.

A third case showed neither caseation nor calcification.

A male patient, aged 22 years, had severe pain a year previous to his operation. It was sufficient to double him up and lasted for 2 weeks. The pain recurred 5 months before the operation. The operation notes did not state the condition of the appendix unfortunately, but there was a mass of mesenteric glands proved by section to be tuberculous and there was no sign of calcification.

In the absence of definite radiological information, it may be assumed that the majority of glands are well on the way to complete calcification at the end of a year after infection with tuberculosis. Many have probably commenced to calcify within half that time. Radiological evidence at intervals of a month in a series of patients of different ages would be most valuable. The dangers due to rupture of a gland or to the formation of adhesions and bands during caseation are considerable. Perhaps one of the greatest safeguards which the patient has against them is the patchy distribution of the areas affected. To the naked eye, and also in the x-ray pictures of the condition, it is frequently seen that the masses of calcareous material are not in the first instance homogeneous but are distributed in many small centers which give the typical "speckled" appearance in the x-ray film. Parts of the gland at this stage feel "shotty." These multiple areas of caseation are not likely to cause so much gross peritoneal reaction as would a single large caseating mass. The chance of a gland bursting is also lessened.

Calcified glands loose in the peritoneal cavity. Occasionally calcified glands are found lying free in the abdominal cavity. The most likely explanation of this is that the weight and movement of the gland gradually stretch the mesenteric covering until it is attached only by a pedicle and eventually the pedicle gives way.

A female patient, aged 29 years had had pains in the side for 4 years. They were dull and intermittent lasting for a day or so with a few weeks' interval. During the previous 5 weeks the pain had remained constantly in the right side and had been accompanied by repeated nausea and emesis. The right ovary was found to be prolapsed and the appendix showed signs of recent inflammation. A small calcified gland lay free in the pelvis. The patient reported that she had been in better health since the operation 8 years before, had gained in weight and was free from any symptoms. The bowels were regular without aperients.

Calcified glands lying free in the pelvis have been found by one of us (G.H.C.) on 3 occasions during 11 years in a total of 2,541 abdominal operations, but in many of the upper abdominal cases, the pelvis was not examined through the wound. An appendix epiploica may become detached in a similar way (Colt, 9) and calcified uterine fibroids may also be extruded.

It is interesting to speculate on the pathology of a calcareous mass ¾ inch in diameter observed on the free border of the liver near the gall bladder in a woman, aged 28 years, who had had stabbing pain on and off in the lower abdomen with radiation to the left breast for 18 months. There were in addition some calcareous masses in the mesentery. Whether the original lesion was a caseating tubercle of the liver or, as would appear more likely, a mesenteric gland which by some means had become attached to the liver and, later, pulled away from the mesentery, it is impossible to say as it was not removed. The gall bladder was normal, and nothing in the previous history pointed to an explanation.

The cause of the symptoms. Carson (7) was emphatic that a diagnosis could be made from pain alone:

I believe that it is absolutely diagnostic. . . . But the main symptom is pain and its character is absolutely typical. It is a sudden centralized abdominal pain, severe enough to make the child cry, lasting for about fifteen minutes or less, relieved by pressure and hot applications, recurring perhaps two or three times a day and stopping as suddenly as it began, so that in the intervals the patient is quite free. In some cases pains occur every day, in others only at intervals of a month or so, the attack

lasting two or three days. . . . I do not know of any other disease in which pain of this type occurs.

A strong odor of acetone in the breath is characteristic of even mild attacks and is independent of vomiting.

Many surgeons have sought to explain how the symptoms are produced.

Golden and Reeves state:

> The mechanism of the production of symptoms by tuberculous mesenteric lymphadenitis, in the absence of previously mentioned complications, is not clear. It should be emphasized that a solidly calcified node seems to be just as able to produce pain as uncalcified actively diseased nodes.

They also mention the possibility of a nervous origin. From the same paper other suggestions are that the symptoms are due to cicatrization (Klein), or to involvement of nerve trunks in adhesions (Kantor). Kiss has shown that the mesenteric lymph nodes are traversed by nerves. Schloesman—quoted by Golden and Reeves—considers that the relief of pain following the operation is due to the severing of these nerve fibers and to the reduction of tension on the peritoneum, the colic-like nature of the pain indicating that the physiology of the intestine is abnormal. The late H. Tyrrell-Gray, quoted in Braithwaite's paper, suggests another cause for the pain:

> Inflammation of mesenteric glands, whether acute or chronic, may be associated with colic, which nearly always arises in the small intestine or the ileocolic angle. The primary focus in the intestine may itself be responsible for the pain, as already described; but the glands themselves may also be responsible. For the inhibitory segment of the peristaltic wave normally exerts a physiological degree of tension in the mesentery during its passage, and, in the presence of inflamed glands, drags on these and causes pain.

In this series it is evident that there must only very rarely have been any lesion of the gut itself. The tension exerted by the passage of the inhibitory wave must be very slight and if such minute changes were able to give rise to pain, the passage of the intestinal contents alone, especially if they were inspissated, would be a more likely factor. The symptoms have been variously described by Auchincloss to pressure on the lymph and lacteal drainage, pressure on the blood vessels causing congestion, pressure on the sympathetic and to reinfection (allergy). In fact there appears to be no one satisfactory explanation if a different theory is applied to each individual case. The symptomatology may depend to some extent on the situation of the glands.

The following are three typical histories which have been selected from the cases under review:

A male, aged 21 years, at intervals of a day to 2 months for 1½ years had attacks of abdominal pain. The pain started to the left of the umbilicus and a shooting pain went to the right. The first attack was acute and lasted 3 minutes. The pains were unrelated to food and were worse after a day's hard work. There had been no emesis but for the last month there had been nausea. The patient was more easily tired than he used to be. His appetite was good and his bowels were regular. His previous health had been good. In the family history there was *nil ad rem.* At operation in 1932, the appendix was found to be fibrosed throughout its length. Two calcareous glands, one the size of a cherry and the other twice that size, were found in the mesentery of the ileum and were removed. Appendicectomy was also done. The questionnaire reply in 1934 was "Relieved of symptoms and better since operation."

A male, aged 28 years, for 4 years had suffered from midepigastric pain extending to the umbilicus, coming on 1½ to 2 hours after food. He always had heaviness and discomfort after food with flatulence and nausea but no vomiting. He had always suffered from constipation and required to take aperients regularly. As a boy, he suffered from indigestion. Recently he had lost weight. He had a good appetite but was afraid to eat. The general condition was good. There was some slight tenderness and hypertonus of the muscles around the umbilicus. The report of the barium meal was "D.U.+statim: D.U. =one hour." One or two calcified masses were seen anterior and to the right of the fifth lumbar vertebra. At operation a very marked sigmoid band was found and divided. The cecum was very adherent to the lateral pelvic wall by old fibrous tissue. The appendix showed distal atrophy but was otherwise greatly thickened. There were small shotty glands and three large calcareous ones at the root of the mesentery. The abdomen showed general evidence of old tuberculous peritonitis. The pylorus was spasmodic. The three large calcareous glands were removed, appendicectomy was performed, and 2 pints of saline left in the abdomen. Three years afterward the patient was seen and said that he had been very well since the operation. His appetite was good. He had gained 6 pounds in weight. The bowels acted regularly, very seldom missing a day. He had no indigestion. The scar was sound.

Female, aged 28 years, had had right sided abdominal pain for 3 to 4 years. Initially it was like a

strain, worse on lifting heavy weights. There was a dragging pain, always in the right iliac fossa, which lasted a day now and then; it was worse lately before periods and after food. There was no nausea or emesis. Bowels opened regularly. There was some frequency of micturition when pain was bad. Periods were regular. On examination there was found some tenderness, with referred pain, to the midepigastric region on palpation over McBurney's point. At operation the appendix did not appear to be pathological. One calcareous mesenteric gland was found and removed and appendicectomy was done. Four years after the operation the patient reported that she suffered from "wind," constipation, and pain in the scar since a very bad "attack of adhesions," but that she had gained a stone in weight, was in better health than before the operation and had been relieved of her pain.

Intestinal obstruction caused by tuberculous abdominal glands. The potential dangers of intestinal obstruction caused by areas of peritoneal reaction becoming adherent to surrounding structures are well known. Two unusual findings in which multiple holes were found in the omentum and in the mesentery, probably caused by the separation of such firm adhesions, are not at all well known and would repay future investigation.

When the local tuberculous process is very active and a caseous gland ruptures, local or general tuberculous peritonitis ensues. The rapidity with which perforation becomes sealed off may tend to obscure its occurrence. The following case is suggestive of this, and being one of generalized tuberculous peritonitis is not included in our totals:

A male, aged 20 years, suffering from left sided knife-like abdominal pain which radiated to the other side and later settled down becoming a dull continuous ache, was found at operation to have tuberculous peritonitis. The peritoneum was thick and tough. There was a large amount of free fluid in the abdomen. The whole of the mesentery of the small gut and the omentum were thickened. The gut was covered with small tubercles. Numbers of enlarged glands were present. The perforation in the gland was not found. The abdomen was closed without any operative measures except the removal of the fluid and a part of the omentum for examination. The condition of the appendix was not stated. The omentum microscopically was tuberculous. Five years later this patient reported that he was better in health, had been relieved of his symptoms had lost only 2 pounds in weight, had a regular movement of the bowels without aperients, and suffered not at all.

The point is also confirmed by Riseley who records a case in which generalization occurred in 11 days.

The patient, a boy aged 9 years, was operated on for partial obstruction. The lower ileum was adherent to the ascending colon near the cecum and to a large perforated tuberculous gland in the mesentery. Several smaller mesenteric glands were present. The peritoneum was normal. The abdomen was re-opened on the eleventh day for signs of recurrent obstruction and a few fresh adhesions were freed. The whole peritoneum, both visceral and parietal was found to be thickly studded with tubercles, several of which were excised and reported to be tuberculous. The patient was well 4 years later except for a hernia of the scar.

Apart from strangulation in external hernia, small gut obstruction is a comparatively rare condition. Internal hernias account for about half the cases and another quarter are due to bands and adhesions (Moss and McFetridge). The importance of tuberculous glands in this latter group must be considerable. Hurst states that bands and adhesions which result from local peritonitis are the commonest causes of acute intestinal obstruction in children and young adults. The following cases of intestinal obstruction due to tuberculosis occurred in our series:

Acute obstruction. There were 10 cases with 3 deaths. The ages of the patients are of interest from the point made in Carson's paper (6) that caseous glands are a frequent cause of intestinal obstruction in "young people." The ages were 12, 18, 19, 22 (2), 24, 29 (2), 35, and 62, the average age being 26.9 years and the median 23. One of the patients had a history of appendicectomy 3 years previously, but at the second operation the appendix was found to be normal and the obstruction not connected with the old operation area. The first operation had been done for an appendix abscess. Another patient had had a pyloroplasty for a leaking duodenal ulcer 4 years previously, and this operation also appeared to be unconnected with the obstruction which was due to a caseous gland.

In 6 of the cases the glands were stated to be calcareous, in 3 caseous, and in 1 calcifying. All the obstructions were of the small gut. One patient had a condition of volvulus. The other cases were mostly due to internal stran-

gulation of the gut by bands adherent to the glands, to the mesentery in their vicinity, to the parietal peritoneum, to the omentum or more frequently, to the small gut itself. In 1 case the obstruction was due to the gut having become drawn up and kinked by the contraction of the mesentery which had become adherent to itself.

The glands causing obstruction were variously situated. One was in the transverse mesocolon, all the others were in the mesentery of the small gut; 3 were stated to be at the root of the mesentery; 2 being in the ileocecal angle; 1 at the middle of the mesentery; 1 at the "upper" part of the mesentery and in the other cases the exact position in the mesentery was not stated.

Four patients required operative treatment of the obstructed gut itself. Of these 1 patient recovered after resection of 3½ inches of ileum. The others died: in 1 an enterostomy was done for gangrenous gut; in another, a resection of 18 inches of ileum was done for gangrene; and in another, an entero-enterostomy for axial rotation of the lower end of the ileum was carried out.

Axial rotation of part of the intestine. This is a dangerous and difficult pathological condition to deal with and is caused by contraction of the fibrous tissue round a focus of inflammation attached to the wall of the gut. It is generally seen in the ileum where the gut is more movable and where a vascular, multiple distribution of tubercle along the ileocolic artery is common. The rotation seen in this series and in other cases has been anticlockwise, as one might expect from the anatomy there, and as much as one circle and three-quarters in amount which no one would expect. The operative unravelling is difficult and takes far too long to be warranted at any operation performed for acute or chronic obstruction. The gut may be seriously depleted of its blood supply and easily injured. The quick detection of the actual pathological condition is apt to be a very difficult matter, chiefly because it is not well known. If it is made out soon, a safe course to pursue, when the obstruction is only recent and the blood supply sufficient is to perform a lateral anastomosis between the small intestine and the cecum or ascending colon. Later the loop of bowel may be removed if necessary. Such a loop in this region may become water-logged and in a case known to one of us (G.H.C.) was felt by the patient to flop over from time to time. A large evacuation of watery feces followed this sensation. Removal of the loop of bowel resulted in cure. When, however, the obstruction is not of recent duration it will be necessary to perform a temporary enterostomy and later a resection. Such a resection should always follow the relief of the acute condition as soon as considered safe, because the loss of strength is rapidly progressive from day to day, and the active digestion of the skin of the abdominal wall is constantly present and difficult to prevent. The pain of this combined with the loss of nourishment can be permanently stopped only by a radical operation.

In the museum of Aberdeen University there is a specimen of the skin of the abdominal wall showing a large number of inflamed, warty processes caused by the action of the succus entericus continuing for 4 months. The pain had been severe. Resection of the fistula cured the patient.

One patient developed acute obstruction of the sigmoid after an operation in which a gland had been removed. The obstruction was due to the adhesion of the sigmoid to the site of a freed Lane's band in the lower ileum. A third operation was later required for a second obstruction which was due to adhesion of the bowel to the peritoneum near the scar of the second operation.

Symptomatology. The symptoms and signs were those usually found in acute obstruction. The duration ranged from 6 hours to 5 days; the average being 36 hours. Five of the patients had had similar attacks previously which were characterized by abdominal colic. Males were more frequently affected than females in the proportion of 7 to 3. The fifth day patient showed bluish discoloration around the umbilicus, which is also well-known to occur in some cases of ectopic gestation and acute pancreatitis.

In 3 cases the glands were removed at operation and all were calcareous. In 3 cases the glands were scraped and the cavity peri-

tonized—all were caseous. In 3 cases—all calcareous—the glands were not removed. In the other cases where the glands were calcifying there is no mention in the notes whether they were removed or not.

Acute obstruction of the appendix. There was 1 case in which the appendix was acutely obstructed by adhesions due to a tuberculous gland in the meso-appendix:

The patient a male, aged 14 years, had suffered for a day from right sided abdominal pain with nausea and vomiting. At operation the cecum was found to be fixed at the level of the umbilicus. The appendix was inflamed and retrocecal. One inch from the base of the appendix there was an S-shaped kink caused by adhesions between small tuberculous glands in the meso-appendix. On undoing the kink in the specimen, fecal material and pus poured from the whole length of the appendix. Six years later this patient was free from symptoms and in better health than before the operation.

Subacute obstruction. In addition to the 10 cases of acute obstruction there were 3 cases of partial or subacute obstruction. The ages of the patients were 16, 17, and 18 years. One had a partial volvulus, to the left of the small gut at the duodenojejunal junction, caused by a large mesenteric gland. A year previously he had had an attack of pain similar to the one which led to operation. The second had a coil of small gut passing through a loop between the omentum and a caseous mesenteric gland. There was no history of previous attacks of pain. The third was a patient who had had appendicectomy done successfully 2 years previously. At the second operation, the small gut was found to be obstructed by an adhesion to a calcified mesenteric gland for 1½ inches. The appendicectomy scar was free from adhesions. The patient had had attacks which had occurred at intervals of 3 months, both before and after the appendicectomy, and these attacks were similar to the one for which he required operation.

Adhesions. The incidence of abdominal tuberculosis is much higher in the north than in the south of the British Isles. It would appear that in any consideration of "the adhesion problem," the facts found to be true for the south are not necessarily true for the north. Dingwall-Fordyce, in 1908, gives the following statistics:

Out of 23,930 children treated in the hospitals in Edinburgh and Glasgow, the percentage of cases with abdominal tuberculosis was 3.9. The figures for the North-Eastern Hospital for Children in London were 10,538 with a percentage of 1.3 with abdominal tuberculosis. The figures for America are even lower; in 37,120 cases the percentage was 0.28.

It is probable that a tendency to adhesions is present in patients operated on for other abdominal conditions who have had a mild degree of tuberculosis of the abdomen in childhood. Adhesions were noted at operation in over a quarter of the total cases in the whole series of 239—caseous and calcareous. The majority were found in the cases which later required further operation. The liability to their formation is evidently much greater than in non-tuberculous persons. Some of the adhesions were due to old appendicitis and were not of a nature likely to give rise to any obstructive lesions; for example, small bands and filmy adhesions were noted between the appendix and the cecum and the surrounding peritoneum.

Omentum adherent to scar. One very practical point noted almost invariably in the re-operation cases and well known to all surgeons, is the tendency for the omentum and bowel to adhere to the upper end of the scar, where operative trauma seems less likely to happen than at the lower end. It would be expected that if adhesions were due to the organization of blood or serum they would form at the lower end of the scar, as any effusion would tend to gravitate downward in the Fowler position; but as light adhesions may form very quickly and remain when this position is assumed soon after the operation, this may not be a valid objection. As the wounds were sewed up from below upward, it might have been that the peritoneum of the upper end was more difficult of access, had been less freed from the superficial structures, more difficult to close effectively and more easily bruised than at the lower end. It would thus be more liable to contract adhesions or even to gape slightly in a few days' time, leaving a bare area for the certain development of adhesions. But with good muscular relaxation these objections are not valid. When the peritoneum is opened in a patient suffering

from adhesions, or in any operation in which the abdomen has been opened previously, it is therefore advisable to do this at the lower end of the incision if a clear spot is not visible elsewhere, and with a knife in preference to scissors.

Potential obstruction. Apart from the cases already given, some others may be briefly described to indicate the type of adhesions found as being potential sources of obstruction:

A female, aged 17 years, who had had a typical history of recurrent attacks of right-sided abdominal pain over a period of 3 years was found at operation to have a retrocecal appendix which was definitely inflamed in the distal third. A band was found running from the right border of the omentum to the ileocecal angle where there were three shotty calcified mesenteric glands.

A female, aged 31 years, had suffered from right-sided abdominal pain for 8 years coming on in attacks before her periods. The pain radiated to the right leg and was worse on exercise. At operation the appendix was found to be normal. The omentum was tracking toward the pelvis where it was adherent to a calcareous mesenteric gland in the lower loop of the ileum.

A female, aged 35 years, had left-sided abdominal pain for 3 months. The pain was sharp and colic-like and came on in attacks with nausea and emesis. The attacks were becoming more frequent. The pain had been felt recently in the right abdomen. Abdominal examination was negative apart from a positive Lockwood's sign (10). The roentgenogram showed a calcareous mass to the left of the fifth lumbar vertebra. The appendix was bound down and adherent to the bowel in a few places. There were calcareous mesenteric glands in the root of the mesentery of the lower ileum. The glands were removed, appendicectomy was done, the sigmoid band was divided and two pints of saline left in the abdomen. Two years later this patient reported that she was in better health, had been relieved of her symptoms and that the bowels moved regularly without aperients, but she suffered from loss of appetite and weakness.

A female, aged 31 years, had had an operation for a left inguinal hernia 8 years previously. She now complained of a swelling of a similar nature on the right side and of a dull constant ache in the small of the back passing down the back of the right leg. She was inclined to be constipated. A right paracentral incision was made, and there were found to be several adhesions between the coils of the small gut and two calcareous mesenteric glands about the size of chestnuts. One of these glands had a sharp spike on it.

A female, aged 49 years, had suffered from indigestion, constipation, and anorexia for 20 years, worse for the last 6 months. She complained also of a constricting feeling in the epigastrium accompanied by tenderness. Lockwood's sign was positive. There was a tender palpable mass in the right iliac fossa. At operation a large band was found connecting the base of the gall bladder with the mesentery. The stomach, duodenum, and gall bladder were normal. The appendix was thin and atrophic and adherent to the cecum. There was a large calcified gland in the mesentery of the lower loop of the ileum. Appendicectomy, division of the mesenteric and of the sigmoid bands, which was fairly well marked, excision of the mesenteric gland, and closure of the abdomen were done, leaving in 2 pints of saline. This patient reported 5 years later that she was "better in some ways," had gained in weight, had "not quite" been relieved of her symptoms, still required aperient medicines, and still suffered from occasional slight pain and "wind."

There is little doubt that adhesions in the chronically tuberculous abdomen are as common as they are rare after appendicular obstruction or a ruptured tubal gestation in an otherwise healthy person. These experiences have shown that they are in no way related to such rough usage of the peritoneum as is occasionally inevitable when the muscles are active during anesthesia. Neither do they *seem* to depend on the stage of activity of the tuberculous process. Intraperitoneal saline tends largely to prevent their formation, but in a few cases no such late beneficial effect is seen. The fluid distributes any traces of blood which still adhere to the coils of gut and also separates the coils for a time. This proceeding would appear to be unsound if the active parts of the glands were even slightly damaged during removal, as it might incur the risk of general peritoneal tuberculosis. A patient who has required more than one operation for tuberculosis of the abdomen and remains with a bad result would be a good subject for a clinical test of papain (25).

Cases of appendicectomy followed later by operation for tuberculous abdominal glands and adhesions. In an area where tuberculous disease of the abdominal lymphatic glands is frequent, difficulties often occur in the diagnosis and treatment of other abdominal conditions. The common instance is appendicitis. There were 13 such patients and they all had had appendicectomy previous to the operation at which the glands were removed. Of the total, 4 were males and 9 were females.

Two were associated with caseous glands and the others with calcareous glands. It is remarkable that in 10 patients the ages were under 22 years, the 3 others being 29, 31, and 39 years. Six female patients required a third operation and one a fourth. In 7 of these cases, the right paracentral incision had been used, in 2 the gridiron, in 1 Battle's, in 1 an inguinal, and 2 were not specified. The smaller incisions are inadequate unless a definite acute condition of the appendix is found and may then also be inadequate if tuberculous abdominal glands are the cause of it. The fact that in 10 of the 13 cases operation was done elsewhere makes it difficult to criticize, as the commencement of the cases had not been seen. We were able to follow up all our own patients. No generalization can be offered unless it is that when in a young person the diagnosis of a supposed acute appendix is in doubt, the possibility of caseous or calcareous glands being the cause should be remembered, and if operation is performed, the right paracentral incision should be used. This apparently adds somewhat to the risk run by the patient should acute appendicitis be the sole pathological condition (8).

Cases requiring more than one operation. Ten of 31 re-operation cases, chiefly the earlier ones, had been done at other hospitals or in other wards of the Infirmary, and it was difficult accurately to collect all the required information. Some cases had followed the use of small lateral incisions for the appendicectomy when the symptoms had really been due to the glands.

TABLE II.—RE-OPERATION CASES

	Type of operation	Traced	Untraced	Excellent	Good	Poor	Bad	Dead
Group I	1. Appendicectomy and glands 2. Adhesions	4	1	3				1
Group II	1. Appendicectomy and glands 2. Adhesions and glands	3					3	
Group III	1. Appendicectomy 2. Glands and adhesions 3. Adhesions	4		1	1	1	1	
Group IV	1. Appendicectomy 2. Glands and adhesions	5	1	2	2	2		
Group V	1. Appendicectomy and glands 2. Adhesions 3. Adhesions	2	2	1	1			
Remainder	(Various)	13		5		5	3	
	Totals	31	4	12	4	7	7	1

Table II shows the cases grouped according to the sequence of the operation and results. Three of the bad results occur in Group II. All were females and suffered from marked constipation. The disease had been progressive. The one death was due to a flare-up of old pulmonary tuberculosis.

The blood platelets in 6 of the cases were counted and the average was 504,000. There was apparently no great, if any, deviation from the normal.

The most usual sequence in these multiple cases was (a) an operation for appendix disease; (b) an operation for adhesions and the removal of calcareous glands; and (c) a last operation for adhesions; or when there were only two operations, an initial appendicectomy and later a gland and adhesion operation, or an appendicectomy and gland removal initially followed later by an operation for adhesions.

One patient who had 5 operations commenced in 1925 with an appendicectomy and gland removal. In 1932 he had two operations, at both of which glands and adhesions were dealt with. In 1933 he had another operation for adhesions and glands. Finally, in 1934, he required a further operation for adhesions. He was seen 9 months after the last operation and still complained of abdominal pain limited to the right side of the abdomen, and occasional vomiting. He suffered from marked constipation. He did not consider that he had been relieved at all by his last operation, yet during the last month he had been decidedly better. The scar was sound and, apart from the abdomen being slightly distended, nothing abnormal could be made out. There was a psychological factor in this case as his home life was not so congenial as hospitalization. His general physique was excellent.

One patient developed a ventral hernia after the operation and it became strangulated 10 years later. The original incision had been a long and high one to explore the gall bladder and the patient was very obese.

Sigmoid bands. Of the 38 cases of caseous glands, there were 13 with sigmoid bands noted at operation. Three were small, 5 were definite or present, 2 were well marked or prominent, and 3 were very marked. The average age was 20 years and the median 19. The sigmoid band cases were associated with calcareous or partly calcareous glands in 6 cases. There were 4 cases with atrophic appendices and the ages were 12, 12, 14, and 21 years. There was 1 case with a Lane's kink and 1 with old perisplenitis.

Of the 184 cases of calcareous glands, there were 74 with sigmoid bands, 40 per cent. Of these, 44 were small, short or slight, 22 were present or definite; 9 were prominent, broad, long or moderate; 15 extensive, marked or fairly well marked; 2 were very well marked or extremely marked. There was 1 case with old perihepatitis, 8 cases with old perisplenitis, 3 with Jackson's membrane, 1 with a fold of Treves, and 4 with Lane's kinks. Sigmoid bands were, therefore, commoner in the calcareous cases than in the caseous and were better formed, which, according to our view, merely illustrates a later stage in the life of fibrous tissue.

In all cases the sigmoid band was divided where it was considered to be interfering with the mobility of the sigmoid. All other adhesive bands such as Lanes' bands, omental adhesions, adhesions between the loops of gut and mesenteric adhesions were likewise divided. (Re-operation cases are excluded in this group.)

Histology of bands and adhesions. In 6 cases, these bands and adhesions were examined for evidence of tuberculosis. Two sigmoid bands were negative for tubercle bacilli. Two omental bands were examined. Both were composed of organized fibrous tissue—one rather vascular. A jejunal band was examined and found to be composed of very vascular fibrous tissue. One Jackson's membrane was examined and no evidence of tuberculosis found.

Etiology. A common sense explanation of the cause of sigmoid bands, Lane's bands and pelvic adhesions is that they are due to organization of fibrin left by the absorption of effusions and pools of lymph lying in the various watersheds of the peritoneal cavity, such as the left concavity of the mesosigmoid. Even the usually accepted congenital origin may be explained by hydroperitoneum during fetal life or in infancy. They show a chordal as well as a radial contracture in their fan-like distribution. On numerous occasions in this series (and in another series of some 1200 cases of chronic appendicitis), it has been possible to peel off the bands without injury to the peritoneum. This is notably the case when the history is a short one and when the bands are flattened sheets of pale pink or yellow, organizing fibrin. In cases of longer duration, in which firm fibrosis is present incorporated in the peritoneal surface, this is inevitably injured by removal of the band and has to be re-peritonized. There is evidence in some re-operation cases that some degree of contraction may occur under the new peritoneal surface.

Jordan, in a paper dealing with fixation of the iliac colon by acquired bands writes:

> This fixation can be shown to begin very early, indeed in infancy, and is due to constipation. It is one of the earliest results of intestinal stasis. This early commencement of fixation has led surgeons to conclude that the fixation is congenital, whereas it is, undoubtedly, acquired.

The radiological demonstration in his paper should be consulted by those who have occasion to deal with these cases. Whether the stasis and constipation can be shown "significantly" to be due to old tuberculous peritonitis will be for future observers to decide. We may be able to produce some small amount of evidence when the analysis of the larger series referred to has been completed.

Enlargement of pyloric glands, etc. Apart from spasm of the stomach and duodenum, glandular enlargements and thickenings may give rise to symptoms and signs of duodenal ulcer. At operation there is little difficulty in deciding the pathology in a typical ulcer or in a typical gland condition, but there is apt to be very great difficulty in some that are atypical. The mass is of so doubtful a nature, even after reducing some of the edema by pressure, that it is justifiable to open the duodenum. The x-ray diagnosis also depends largely on the abolition of spasm and may, in

consequence, be misleading. In this series we have had 12 cases in which doubt arose, and in another series duodenal ulcer had been confirmed radiologically in 13 cases, but when the duodenum was opened no ulcer could be seen. It is possible that these abnormal thickenings occur in cases of low grade, or of chronic but still active, abdominal tuberculosis, and attention is drawn to them so that others may be able to add their observations in the future.

Tuberculosis of the appendix. Of 93 of the gland cases in which the appendix was examined microscopically, one was found to be tuberculous.

A female, aged 16 years, had lower abdominal pain commencing the day before her admission. There was a history of many previous attacks of less severity. The appendix contained concretions. There were calcified glands in the mesentery near the appendix and a small lutein cyst of the left ovary. The cyst was punctured, the glands removed, and appendicectomy was performed. The pathological report was "lymphoid deposits in mucosa very prominent and active; minute area histology suggestive of tuberculous appendicitis." This case was untraced and is included in Group IV of the calcareous cases.

In one adhesions case tubercle of the appendix was found:

A male, aged 48 years, was admitted on account of right-sided abdominal pain of 6½ hours' duration which was relieved. He was operated on some 3 months later for attacks of colic-like pain in the right iliac fossa with a vague generalized abdominal ache, nausea, and intractable constipation. Occasionally he had had very severe attacks of indigestion. At operation there was an extraordinarily well marked sigmoid band, marked chronic inflammation of the appendix which was completely adherent to the cecum; there were numerous pericecal adhesions which immobilized the cecum to the lateral pelvic wall by dense fibrous bands; one band ran from the lower ileum to the cecum. On section the appendix showed a medial stricture with a concentric ring of ulceration and marked distal atrophy. All the proximal coats were hypertrophied. The section showed the ulceration to be tuberculous. The sigmoid and also the ileal bands were divided appendicectomy was performed; and 2 pints of saline was left in the abdomen. Four years after the operation the patient stated that he was now in better health, had been relieved of his symptoms, had gained in weight, and only occasionally suffered from heartburn.

Gangrenous appendicitis came on in a patient who was known to have tuberculosis of the right lung.

A female, aged 20 years, gave a 3 days' history of abdominal pain of sudden onset becoming worse on the day of admission and accompanied by nausea. She had been in hospital before for a similar attack which subsided. At that time she remained in hospital 3 months and was treated as a tuberculous case. At operation, the appendix was found to be gangrenous, the omentum wrapping it round and shutting in an abscess. The cecum was edematous and showed signs of old inflammatory thickening. Appendicectomy without opening the abscess was done and the wound was closed with drainage. The report on the appendix was "chronic tuberculosis of the appendix with acute inflammatory changes." A week after the operation the wound was still discharging hemorrhagic fluid (containing lymphocytes) and the patient was having marked pyrexia. At the end of a month the wound had healed, and she was discharged to the hospital she had been in previously. Three months later she died of phthisis.

Comment on operative technique. In order to test the results of this part of the work, every effort was made to secure personal continuity in the re-operation cases. By following up the cases every 3 months for many years, it was possible to ensure that few, if any, were missed unless they had left the district, and many of these were heard from.

The older teaching that it is inadvisable to remove caseous or calcified mesenteric glands does not apply with such force today. In this series the glands were removed whenever the condition of the patient warranted it.

The incision. A right paramedian incision was generally used, the rectus being retracted outward. The height of the incision was variable depending on the position of the glands, the suspected presence of complications and on any other pathological conditions present, but was preferably subumbilical. Carson used a midline infra-umbilical incision. In only a few cases, when glands were numerous or small or when the operation was undertaken for acute appendicitis, were they not removed. When they were situated in a dangerous position as regards the blood supply of the small gut, they were left at the time, but even in these cases they had often subsequently to be removed, especially when situated high up in the vertebral attachment of

the mesentery. The subsequent histories of 2 such patients showed "much improvement" in 1 and in the other loss of weight, constipation, and backache.

Care is always required. The intimate relationship with the vessels and the fact that the latter may run through grooves on the gland surfaces or lie in tunnels between them make for danger. The higher up in the mesentery, and the nearer the lumbar spine, the greater the care required. The vessels are larger there and the greater depth in the abdomen makes the procedure troublesome. Removal of the glands may leave a hole on each side of the mesenteric leaf and care must always be taken in closing it. *Both sides must be inspected* to see that no raw area is left. Carson in his paper emphasizes this: "After removal of the glands the greatest care must be taken to sew up the incision in the serosa." The repair should be done radially to avoid shortening the mesentery. The vessels are often densely adherent to the glands. The veins being thin and stretched are especially difficult to avoid. There was only one case in the series in which ligature of the vessels gave rise to any apparent disturbance of the circulation. Usually the ligatures were lateral ones. In one case only was there a spreading hematoma of the mesentery due to the bleeding being very free and the source difficult to find.

In removing the glands it is advisable for the assistant to grasp the bowel and the mesentery between the fingers and thumb of one or both hands so as to hold the glands forward for the operator. This may be difficult or impossible if a gland lies near the vertebræ or if the mesentery has become contracted. Removal is commenced by cutting the peritoneum over the gland or sometimes at its side. The peritoneum is dissected back with the knife, the cutting edge being held toward the gland. The smaller vessels are secured as they are cut, and unless numerous, the forceps are left on until the dissection is finished. Some may prefer to dissect out the glands with scissors, but a longer time is required though the bleeding is less. The danger of tearing an adherent vein is greater by this method than by using a sharp knife. A good light is essential. Fine linen is a good ligature and suture material for this work as it is less likely to slip than catgut. The use of silk was discontinued in 1920 on account of its becoming rotten and uncertain when boiled with the slightest trace of alkali, and from its tendency to curl, whereas linen can be boiled many times in weak soda and water without deterioration. It is remarkable how many vessels are cut even in the removal of a small inflamed gland, and it may be advisable to tie off a number of forceps before proceeding to the complete enucleation especially in the case of a large gland. Great care should be exercised by the assistant to avoid putting any tension on the structures when the vessels are being tied or at any time later. A point to be remembered is that with the mesentery on the stretch bleeding may not occur until the structures are relaxed and then it may be very free. Tests should always be made. Conversely, stretching the mesentery may eject a ligature from a short stump. Carson states the difficulty mildly when he wrote "These operations may be very difficult and trying."

When caseation is present, or the gland relatively large, its content may be eviscerated, part of its capsule removed, and the edges closed and peritonized. In some cases of acute obstruction, drainage of the abscess for a short time seems justified. Some surgeons have advocated the use of omental grafts to cover any raw area left on the bowel wall and so prevent the formation of a sinus, especially when the gland is at the junction of bowel and mesentery. There would not appear to be so much danger of sinus formation in the case of calcareous as in caseous cases. The subsidence of inflammation allows a gland to resume its normal position in the mesentery at some distance from the gut itself.

Of the 269 operations, 219 were done by one surgeon, 39 by another and the remaining 9 by deputy.

Two of the patients had slightly keloid scars. This does not give the true number because less than half of the patients were examined during the follow-up, the others being traced by questionnaire. These keloids sub-

side with time independently of any radiation. In the cases in which patients had only been traced for a comparatively short period, less than a year, there were many complaints of burning, tingling, or itchiness in the scars some of which were keloid in the earlier stages, but there was no case with a scar which had remained permanently hyperesthetic. Glycerine relieves the itching.

Three patients in the series had ventral hernias; in 1 after 1 operation, in 1 after 2 operations, and in 1 after 3 operations. These were 3 cases of general weakness of the lower abdomen. One patient had an incipient right inguinal hernia after a right paracentral incision. In 6 cases there was widening of the skin but none of the deeper layers.

TABLE III.—RESULTS OF OPERATIVE TREATMENT

Nature of case	Excellent	Good	Poor	Bad	Died	Total
Caseous	27	3	1		5	36
Calcareous	109	17	6	8	4	144
Re-operation	12	4	7	7	1	31
Totals	148	24	14	15	10	211

The 10 deaths are accounted for as shown in Table IV.

It is evident that the removal of tuberculous abdominal glands has not met with successful results in all cases, though it would seem that the results are better the more complete the removal especially if done in the intervals between attacks. Removal during the process of calcification seems to be unsatisfactory and tends to the formation of adhesions. If there is radiological evidence that calcification is still in progress the case should, if possible, be continued without operative interference and operation may not, ultimately, be found necessary. It is to be hoped that the use of papain (25) in future cases will provide a welcome improvement.

Possibility of stirring up tuberculosis elsewhere. It has been suggested that the removal of these glands is likely to stir up old quiescent lesions either in the abdomen or elsewhere. One of Carson's patients developed phthisis and recovered, and another developed phthisis and died 11 months after operation. There were 5 cases in this series which might point to this possibility:

CASE 1. A female, aged 28 years, died from phthisis 4 years after the gland operation. She had a very strong family history of tuberculosis—6 of the family of 10 had died of tuberculosis—4 of lung disease and 2 of intestinal. The patient had a caseating gland the size of a hen's egg. She had suffered from pulmonary tuberculosis for 3 years previous to her operation.

CASE 2. A male, aged 44 years, had cholecystectomy for stones. Several calcified glands in the ileocecal angle were removed. He developed phthisis and is now under treatment.

CASE 3. A female, aged 12 years, was suspected of lung tuberculosis. She took 2 years to convalesce from the operation at which a fairly large number of tuberculous glands were found and removed.

CASE 4. A male, aged 34 years, died on the fifth day after operation for adhesions. Death was due to stirring up an old phthisis. The gland operation had been done 2 years previously.

CASE 5. A female, aged 23 years, was admitted to a medical ward for 6 months following the operation, with tuberculosis of the lung. At operation a large calcareous gland was removed from the root of the mesentery.

A male, aged 12 years had all types of tuberculous mesenteric glands as well as tubercles in the lower ileum. He died some time after the operation from phthisis.

The last patient is not included in the series. He had generalized peritoneal tuberculosis surrounding the glands and very many small glands in all stages of activity.

FAMILY HISTORY OF TUBERCULOSIS

1. J. C., aged 16 years, 1932, mother died of tuberculosis.

2. B. W., aged 34 years, 1932, mother and sister phthisical. Patient also had lesion of lung at time of operation, and treatment for lung disease 15 years previously. Father died of pulmonary tuberculosis.

3. J. R., aged 12 years, 1931 (brother of B. R. below, 1929), four of family, all delicate in youth, with also a family history otherwise suspicious of tuberculosis.

4. B. R., aged 17 years, 1929 (sister of J. R. above).

5. E. D., aged 17 years, 1931, mother suffers from tuberculosis and there is a very strong family history of tuberculosis.

6. M. P., aged 23 years, 1931 (brother of W. P. below) suffered from calcareous glands in abdomen.

7. W. P., aged 23 years, 1925 (brother of M. P. above).

TABLE IV.—TOTAL MORTALITY

Surg.	Age and index	Type of case	Type of operation	Cause of Death	Survival period
2	1. 29 (F. R. 1932)	Caseous gland and 2 duodenal ulcers	Removal of gland and appendix, posterior gastrojejunostomy	Septic peritonitis and paralytic ileus	1 wk.
2	2. 24 (R. B. 1931)	Caseous gland. Small gut obstruction	Entero-enterostomy, gland scraped	Postoperative lobar pneumonia	1 day
1	3. 52 (J. Y. 1928)	Caseous gland. Acute appendicitis	Appendix and gland removed	Peritonitis	5 days
1	4. 28 (G. W. 1932)	Caseating mass in mesentery	Appendix and part of mass removed	Postoperative shock	1 day
1	5. 28 (E. N. 1925)	Caseating gland	Removal of gland and appendix	Phthisis	3 yrs.
1	6. 62 (W. C. 1925)	Calcareous glands, acute intestinal strangulation	Resection of 18 inches of small gut	Postoperative shock	2 days
1	7. 29 (J. M. 1932)	Intestinal strangulation. Gangrene of gut. Calcareous glands	Enterostomy	Postoperative shock	Few hrs.
1	8. 43 (J. W. 1929)	Calcareous glands. Slight adhesions	Appendix and glands removed	Burst wound—postoperative peritonitis	11 days
1	9. 15 (I. C. 1930)	Mitral stenosis. Calcareous glands	Removal of glands and appendix	Postoperative hemiplegia. Acute heart failure	2 yrs.
1	10. 32 (B. W. 1930)	Adhesions. Calcareous glands. Potential hernia of mesentery	Appendix and glands removed, repair of mesentery		
	(B. W. 1932)	Postoperative adhesions	Freeing of adhesions	Flare-up of phthisis	6 days

Total cases..... 239
Total operations..... 269
Deaths due to operation 5, to strangulation 3, to phthisis 2, Total 10.

8. A. N., aged 8 years, 1929–30 (sister of W. N. below), suffered from calcareous abdominal glands and required a second operation for adhesions and glands.

9. W. N., age 12, 1928–29 (brother of A. N. above), also suffered from calcareous mesenteric glands and required 2 later operations for adhesions. One other member of the family died of tuberculous meningitis, others had been under treatment in a hospital for tuberculosis and an uncle had a tuberculous lung.

10. M. B., aged 12 years, 1925, brother had weak chest, very possibly tuberculous.

11. E. N., aged 28 years, 1925. Six of 10 brothers and sisters died of tuberculosis, 4 from disease of the lungs and 2 from intestinal disease. Two of father's sisters also died of tuberculosis.

Thus a more or less strong family history of tuberculosis was obtained in 11 cases. Six of these cases were brother and sister from 3 families. Five of the cases were suspected of extra-abdominal lesions and are included in the "personal history" series. Six of 10 brothers and sisters died of tuberculosis and of the 6 deaths 2 were due to abdominal tuberculosis. Another patient had almost as strong a history, the father died of tuberculosis and the mother and sister of the patient were phthisical.

PERSONAL HISTORY OF TUBERCULOSIS

1. A. L., aged 23 years, 1932. At the time of the operation was suspected of having renal tuberculosis.

2. B. W., aged 34 years, 1932. Was in convalescent home 15 years previously for phthisis. Suspected to have lesions at right apex at time of operation. Died 6 days after the operation from "flare up" of the old phthisis.

3. M. P., aged 23 years, 1931. X-ray examination at time of operation showed the left lung to be blurred. ?fluid. Postoperative treatment for 6 months for phthisis.

4. J. R., aged 12 years, 1931. Delicate in youth. Prominent root shadows in x-ray films.

5. W. F., aged 42 years, 1931. X-ray films showed a blurred and mottled right apex with prominent root shadows.

6. E. D., aged 17 years, 1931. Always weakly and suspected of having phthisis. X-ray examination showed very prominent root shadows and peribronchial fibrosis. He had an abscess over the sacrum this year and it was suspected to be tuberculous.

7. E. F., aged 16 years, 1929. Had neck gland incision 7 years previously.

8. B. R., aged 17 years, 1929. Had cervical tuberculous adenitis as a child.

9. D. F., aged 16 years, 1929. Right apical lung disease. Tuberculous.

10. W. N., aged 12 years, 1928. Had pleurisy twice. Thin pale-faced. Some pulmonary fibrosis

shown in the x-ray. Was in hospital previously for 3 months and had latent tuberculosis.

11. J. M., aged 47 years, 1927. A "piner" all his life. Had pleurisy five times.

12. G. W., aged 28 years, 1926. Five years previously had had an operation for psoas abscess. (This patient had a tuberculous salpingitis as well as calcareous glands.)

13. J. I., aged 19 years, 1925. Evidence of chronic pleurisy right base.

14. E. N., aged 28 years, 1925. Cough at times and a very strong family history of tuberculosis.

There does not therefore appear to be a very marked liability to the development of the glandular type of abdominal tuberculosis coincidently with or following on other tuberculous lesions.

Of the total number of 239 cases, there were only 14 patients who, from their past histories, or from examination of their present condition, were actually known or suspected to have had other tuberculous foci. Of these, 10 were suspected to have had pulmonary tuberculosis which in 3 cases was still active. Two had had operations for tuberculous neck glands, one a psoas abscess 5 years previously, and another was suspected of having a tuberculous kidney and epididymis at the time of the operation. Thus of the series of cases there are only 3 patients or at most 4, in whom tuberculosis was present in an active state elsewhere than in the abdomen at the time the operation was performed.

SUMMARY AND CONCLUSIONS

It appears from the literature that the glandular type of abdominal tuberculosis is a severe and often fatal disease in infants and young children notably when the bowel is ulcerated; that in those that survive, or become infected later in life, the disease runs a natural course toward calcification and cure. This course may be a troubled and dangerous one. It is difficult to correlate the effect of any particular kind of treatment with the progress of calcification, but serial roentgenography may help to clarify this factor in the future.

The cases of 239 patients admitted consecutively into a general surgical ward have been reviewed for this enquiry. Family and personal histories of tuberculosis were given in 25 cases, but in only 3 or at most 4 of them was tuberculosis present in an active state elsewhere than in the abdomen at the time of operation. There appears to be very little danger of causing general or local tuberculosis by an operation for the removal of the majority of tuberculous abdominal lymphatic glands.

Excluding one doubtful case, no evidence was found in the abdomen of the portal of infection.

The administration of intraperitoneal saline at the conclusion of the operation tends to prevent the formation of adhesions in abdominal tuberculosis.

The adhesion threshold in abdominal tuberculosis is a low one. When the precautions in common use for minimizing operative trauma are adopted there is evidence that within such limits the formation of adhesions does not depend on peritoneal injury or on the stage of the disease.

Re-operation should be avoided if possible until 2 years have elapsed from the time of the last operation.

The connection between the atrophic appendix and tuberculous abdominal glands is discussed.

No tubercle bacilli have been found in the adhesions, sigmoid bands, omental bands or Jackson's membranes when they have been examined. The formation of such bands and membranes is probably due to the organization of fibrin in pools and collections of lymph. The various stages of their formation may easily be observed.

Every effort should be continued to rid the milk supply in small districts and in large communities of active tubercle bacilli.

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CANCER OF THE BREAST

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IN PRESENTING this paper I want to pay a tribute to the late Robert B. Greenough, whose recent death has resulted in one of the greatest possible losses to students of cancer and to surgeons in general. A very large part of my personal interest in, and knowledge of, cancer has been derived from his stimulating teaching. In writing this paper I have tried to make it as much as possible one that would meet with his hearty approval. As you will see I will quote extensively from his writings.

CURATIVE SURGERY

One would think that during the 43 years since Halsted published his great paper describing the essentials of an effective technique for operation for cancer of the breast his principles would have become either universally used or universally discarded. During the intervening years hundreds of papers have been published concerning the end-results in patients who have undergone this or essentially similar operations. Very few papers have been published which show even approximately as good results when less radical operations have been done. Grace of Brooklyn, however, has recently published a paper in which he claims good results from local mastectomy. He claims 44 per cent of cures in 40 cases, but admits that 80 such operations were performed, and that the follow-up is only 50 per cent complete. Obviously, although he does not say so, he made no serious attempt to get the end-results on his failures by consulting the death records at either the city or state departments of vital statistics. Is it honest for a man to compile a table such as he has, in which he compares his percentages with those of Greenough and others (3, 4, 5, 6, 8, 9) who follow up over 90 per cent of their cases, and then to consider the remainder of his patients to be dead of the disease?

From the Cancer Commission of Harvard University. Read before the section meeting of the American College of Surgeons, Halifax, Nova Scotia, May 20, 1937.

In addition to Grace many surgeons, and among them not a few other members of the American College of Surgeons, perform many non-radical operations in an attempt to cure cancer. Many may honestly be confused by the fact that certain publications of prominent surgeons and pathologists have led them astray. An instance of how this may occur may be found in a very important paper by Allen Graham. This recent paper is used as an example and is not the sole instance that might be cited in this connection. He states, "In a small percentage of cases, simple mastectomy is adequate treatment provided the entire breast is removed. Needless to say, these are cases in which the process has not progressed to the formation of a gross tumor nodule." He then goes on to limit still further the cases in which he makes this recommendation by insisting on a complete gross examination by a competent pathologist to rule out gross tumor. This advice, therefore, applies to a very small number of patients who undergo operation primarily for some benign breast condition, and probably in many instances different pathologists would disagree as to the actual presence or non-presence of cancer. This advice can do no harm if it is followed exactly as given. It is likely, however, that careless readers would not take in the qualifying statements, but would quote Graham as an authority for doing things of which he would completely disapprove. In the next paragraph he goes on to say, "That an amputation of the breast and axillary dissection without removal of the pectoral muscles is adequate treatment for a certain group of patients has been proved to our entire satisfaction." This group he later defines as "early cases without evidence of axillary metastases."

How about this? Two aspects of it will be discussed. First, can one tell by physical examination whether or not axillary metastases are present? In the more recent papers by the members of the staff of the Harvard Cancer Commission this particular point has not been

considered, but it was considered by Greenough and Taylor (6). Therefore, to secure a modern group of cases a consecutive series of 50 recent cases at the Huntington Memorial Hospital has been studied with this aspect in mind. These cases are all examples of primary, operable breast cancer which was proved by pathological examination, and all these patients were operated upon promptly after physical examination had been completed. The examinations were made by various members of the surgical staff, but in all cases the examiners had had at least 10 years' experience in tumor clinic work at the hospital and each had worked also at one or more of the following hospitals: Massachusetts General, Boston City, Pondville, and Palmer Memorial. The operations performed were all radical procedures and consisted of mastectomy, removal of both muscles, and of the axillary contents, all in one piece. This study is shown in Table I.

TABLE I.—CANCER OF THE BREAST, HUNTINGTON MEMORIAL HOSPITAL, 1931–1936. COMPARISON OF PHYSICAL EXAMINATION AND PATHOLOGICAL EXAMINATION OF AXILLARY LYMPH NODES

Physical examination	Pathological examination		
	Positive	Negative	Total
Positive	20	2	22
Negative	11	17	28
Total	31	19	50

TABLE II.—CANCER OF THE BREAST, ACCURACY OF PRE-OPERATIVE DIAGNOSIS OF AXILLARY METASTASES

Pre-operative diagnosis	Massachusetts General Hospital 1921–1923 Correct per cent	Huntington Memorial Hospital 1931–1936 Correct per cent
Positive	68	91
Negative	79	61
Average, per cent	74	76

This table shows that the pre-operative accuracy of diagnosis when glands were thought to be involved was 91 per cent and when they were thought not to be involved it was only 61 per cent. A similar study was made by Greenough and Taylor (6) in 1934 from the cases at the Massachusetts General Hospital.

In this instance it is likely that most of the recorded pre-operative examinations were made by house officers. However, although the preponderant type of error is different, the errors of clinical estimation are essentially the same in percentage as in the later series. Here the examinations were only 68 per cent correct when glands were thought to be involved and 79 per cent correct when they were thought not to be involved. Table II shows both these series on a percentage basis.

With these figures in mind it is clear that one cannot be at all sure on examination whether the nodes are involved. It is admitted that perhaps half of the cases referred to would be considered so advanced by Graham that he would not consider saving the muscles; but the other half were certainly early cases, as I read his criteria, and the percentage of errors in such cases, while it might be smaller than the percentages tabulated, would still be sufficient to make one think that a radical operation is warranted because of the likelihood of the presence of involved glands. It is not doubted that an axillary dissection can be performed by a good surgeon without removal of the muscles, but is it as good a dissection, and can it ever be as complete a dissection as can be done by the same man when the muscles are removed?

The second piece of evidence against leaving the muscles is found in the occasional patient who suffers a local recurrence in the muscles and not in the glands following complete simple mastectomy for "early" carcinoma. Two such patients have been seen at the Pondville Hospital this year (10). Further evidence is seen in the important studies made by the late Dr. Wainwright (13), who before his recent death contributed so much to the study of cancer and its spread. It may be held that the radical operation is too dangerous. This should not be true. In properly selected cases the operative mortality should be in the neighborhood of 2 per cent or less, as has been reported for many years in the Harvard Cancer Commission publications (3, 4, 5, 6, 8, 9), and from many other clinics. For all these reasons we disagree with Graham in advising non-radical operations upon even the few patients with proved cancer of the breast for whom he advised them. We do not believe it is possible to pick out the few patients for

TABLE III.—CANCER OF THE BREAST

Comparative Results by Years (9)

Period	"Cures," per cent	Duration of "cures," years
1894–1904	19	3
1911–1914	27	5
1918–1920	30	5
1921–1923	35	5
1924–1926	41	5
1927–1929	43	5

whom we admit this procedure would be safe.

In the case of individuals sent to the hospital for postoperative x-ray treatment within 1 month following a simple mastectomy, no x-ray treatment is given, but a radical operation is done. In half of these patients definitely involved nodes are found. Where would they be without having had a removal of the nodes? Some surgeons also claim that there is disability from the loss of the muscles. That has never been seen in the many patients upon whom operation was performed at the hospital.

SELECTION OF PATIENTS FOR RADICAL OPERATION

A most important part of Graham's paper shows frankly how many radical operations were performed in a futile attempt to cure the incurable. We agree completely with him that such patients should never have radical procedures and should seldom undergo any surgery beyond a biopsy. A patient who complains of a breast tumor has the following course of study at the Huntington Memorial Hospital.

After a preliminary history has been taken, a careful local examination is made. If the following conditions are found the case is considered to be inoperable. A fixed mass, fixed axillary nodes, any involved supraclavicular nodes, wide skin involvement, subsidiary skin nodules, edema of the breast, and edema of the arm. It is to be noted that a large tumor, locally fixed to the skin or not, and locally ulcerated or not, does not in itself make the situation inoperable. In addition, movable axillary metastases do not do so. After this examination is completed all patients in whom there is a positive or likely diagnosis of cancer are subjected to the following x-ray examinations: chest, lateral view of the thoracic and cervical spine, anteroposterior view of the lumbar spine and pelvis, lateral view of the skull. If metastases are found in any of these plates the case is also considered to be inoperable. If no metastases are found an estimate is made of the patient's general condition, and particularly of the circulatory system and respiratory tract. Complete physical examination is done and occasionally evidence of intraperitoneal extension is found. Operation, of course, is never performed in such instances. If the patient is in good condition an appointment for radical operation is made and the operation is performed the day after the patient's admission to the hospital. If the patient is a poor risk, he is put to rest in bed, studied medically, and treated when indicated for a few days in the hospital. By this regimen a patient's general condition can be so improved as to enable him to undergo a radical operation.

In some cases the diagnosis as to the presence of cancer is a borderline one. In these instances the course of study mentioned is carried out and the patient is prepared for radical operation. An incision is made directly over the tumor, which is incised, or removed with a fair margin of tissue. Immediate frozen section diagnosis is made. If this shows cancer the wound is packed with formalinized gauze and is carefully sutured; the instruments, gowns, gloves, and drapes are discarded. The skin is newly prepared and the radical operation is proceeded with.

TREATMENT OF THE POSSIBLY CURABLE PATIENT

Under the teaching of the late Dr. Greenough, the Halsted incision has not been used for many years. However, we do not disapprove of a properly done Halsted operation. We merely think that in our hands the following operation, which complies in every way with Halsted's objectives, is more easily performed and affords better possibilities for plastic closure when large amounts of skin have to be removed. The transverse axillary or Rodman incision is used. The axilla is dissected first, after the two muscles are divided near their insertions. When this dissection is complete, the breast is removed in one piece with the axillary contents, muscles, and skin. The

skin is removed sufficiently widely so that at times a skin graft is necessary. Recently electrocoagulation rather than tying has been used for all bleeders other than the branches of the axillary vein and artery, but the entire dissection is done with a scalpel or scissors. Coagulation of the bleeders saves much time and results in at least as dry a wound as the former method. An axillary drain is used.

Pre-operative x-ray treatment is not used. Definite proof of its value is not clear to us as yet. We are, however, watching certain work in other institutions with great interest as it is possible that a valuable method of giving this treatment may be worked out shortly. Prophylactic postoperative x-ray treatment is given over the operative site to only a few patients with a highly malignant cancer. However, all women who have not passed the menopause are sterilized by x-ray (11).

TREATMENT OF THE INCURABLE PATIENT

This group is made up of patients with extensive disease as outlined, rarely of patients with operable local lesions who cannot by any preparation be put into proper condition for the operation, and patients with recurrences following radical surgery. These patients are all given high voltage x-ray treatment to the local lesion and all known metastases. Quite large doses of x-ray are given and if the patients are from out of town they remain in the hospital during the course of treatment. Radium is used practically not at all. The lack of useful palliation or cure by inserted platinum needles (Keynes) containing radium has been reported by McKittrick (7). Taylor (12) has already reported the results of such treatment at the Pondville Hospital and elsewhere. Very few non-radical operations are done on a palliative basis, as has been recommended frequently in the past and is being done rather extensively at present in other institutions. X-ray treatment has been found to be followed by healing of the local lesion which is kept in check during the time the patient remains alive. Although, as stated above, we pay little attention to either preoperative or postoperative x-ray treatment we think palliative treatment by this means for the patient who is not a good operative risk or for the patient with recurrence after complete operation is of the greatest value. Within the last 2 months the first treatments on a new one and one-half million volt machine of radically new design have been started. These are still purely experimental and we are not as yet prepared to give a report on the immediate results of this treatment.

RESULTS OF CURATIVE OPERATIONS

The Huntington Memorial Hospital during its existence has been an experimental institute. It has very few beds for house patients and these beds have been used primarily for patients receiving various kinds of radiation treatment, experimental or otherwise. Patients in need of standard surgical procedures have been transferred to other hospitals. In most cases they were transferred to the Massachusetts General Hospital. One of the largest series of papers dealing with thoroughly followed operations and uniformly presented cases is that of Greenough and his coworkers, already mentioned. Table III, which I am including in this paper, appears in the final paper of Greenough's series, and presents what is accomplished by following the principles herein stated.

Before going back to the original papers any younger surgeon might think that the reason the results improved so much between the first and second interval was because the radical operation was less frequently done in the first period. As a matter of fact, this is not true. Dr. J. Collins Warren, who was the founder of the Huntington Memorial Hospital, was a leading surgeon at the Massachusetts General Hospital then, was greatly interested in radical cancer surgery, and he and his colleagues all adopted Halsted's principles in 1894 when they were first published. The percentage of radical operations was as high in the first series as in any subsequent one. We must therefore look elsewhere for these improved results. Although the operative mortality was slightly higher in the early period it was not enough so to make this difference.

The whole difference may be accounted for by a stricter choice of patients to whom the chance of operative cure was offered. This was

accomplished in two ways. First, by assigning such patients to a few individuals instead of having them spread among the whole staff. This accounts for most of the improvement between the first and the second series. This improvement was really greater than the difference between 19 and 27 per cent because in any series studied at a 3 year interval there will be a considerable further loss by the time 5 years have passed.

During the years of the third and fourth series, x-ray study, first of the chest and later of the bones, began to be used to eliminate some cases previously considered to be operable. By the time of the last paper this had become absolutely routine. All the improvement in results of treatment shown in this series of papers can be attributed to three factors: (1) better choice of cases; (2) concentration in the hands of experts; (3) larger proportions of early cases.

SUMMARY AND CONCLUSIONS

1. Patients with suspected cancer of the breast should be very carefully studied before the course of treatment is decided upon. This study includes complete history, physical examination, and x-ray examination of the chest, spine, pelvis, and skull.

2. Following this study the patients should be separated into two classes: (1) those with a chance of cure; (2) those without a chance of cure.

3. The former should undergo radical procedures, without previous radiation treatment. Postoperative x-ray treatment is not a necessary part of the routine for all patients.

4. The patients classed as incurable should be given powerful doses of x-ray, and no surgery and usually no radium.

5. Patients with recurrence following radical operation should have palliative treatment by x-ray and, occasionally, by radium.

6. When patients are treated in this way 43 per cent of those operated upon should remain "cured" for 5 years. Of these, 75 per cent of the patients without positive nodes on pathological examination and 25 per cent of those with positive nodes are "cured."

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FIVE YEAR END-RESULTS IN THE TREATMENT OF CANCER OF THE TONGUE, LIP, AND CHEEK

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IT IS axiomatic that the efficacy of a therapeutic procedure must be determined not by the number, but rather by the percentage of cures obtained by its use. Obviously, the end-results or the percentage of permanent cures in diseases such as cancer may not be calculated except after an extended period of observation so as to preclude the *probability* of late recurrence. However, another factor must be taken into account in all calculations of end-results, namely, the make-up of the group of patients upon whom the calculations are made. Unless the clinical material is of uniform *average* quality, as regards the stage of advancement in patients with cancer, comparative end-results are meaningless. This applies particularly to the practice of selecting only those patients who are "operable," "early" or otherwise favorable.

To be truly representative, a group of cases upon which end-results are reported should consist of a consecutive series of all patients in any and all stages of the disease, whether primary or recurrent, as they present themselves for treatment. Such a concept is, of course, not new, but it is honored more often in precept than in practice. The only permissible deductions from the total are those cases in which the eventual results of the treatment for cancer cannot be determined by reason of death from unrelated causes, and those in which patients are lost track of without recurrence after a reasonable period of freedom from disease (1 year). It will be conceded that neither of these modifying factors is capable of control by the physician nor can they be influenced by the efficacy of the treatment. These factors will be discussed more fully later.

The end-results reported in this communication were calculated on the basis of the foregoing standards and represent a sincere effort to record the actual statistical data as regards the possibility of cure and the prognosis in certain anatomic forms of cancer in our clinic.

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From the Head and Neck Service, Memorial Hospital.

THE LENGTH OF THE POST-TREATMENT OBSERVATION PERIOD

A 5 year period of freedom from recurrence is at the present time generally accepted as a reasonable basis for computing the percentage of permanent control in cancer. The selection of a 5 year period for all varieties of cancer is somewhat arbitrary, since it is well known that the possibility of late or remote recurrence differs considerably in the various anatomical and histological forms of the disease. For instance, it is common knowledge that cancer of the lip or mucosa of the cheek rarely recurs after even 3 years, while in other varieties, such as anaplastic cancer of the pharynx, cancer of the breast, and melanoma of the skin, disseminated metastases may develop 10, 15, 20 years, or even longer after control of the primary lesion.

One must concede, therefore, that strictly speaking, absolute cure of cancer is not assured until the patient has survived for a period longer than that of any recorded instance of recurrence in his particular anatomical and histological variety of the disease. However, statistics based on such long periods of survival would be of little or no practical value in evaluating the comparative merits of several methods of treatment. By the time 20 year, 15 year, or even 10 year cure rates had been determined, the treatment methods employed would necessarily have been considerably modified or superseded, and the series of cases upon which the calculations were based would be greatly reduced by deaths from other causes. Under such severe standards, we should be deprived of the opportunity of modifying and improving our methods on the basis of the experience and results of our contemporaries. During such a long period, the individual investigator himself might

have passed from activity into retirement. A comparison of the methods in use 15 or 20 years ago would be of greater historic interest than practical value. Therefore, it seems likely that considered opinion will settle upon the standard of a 5 year cure[1] as a logical compromise between absolute fact and average probability.

THE LENGTH OF THE PERIOD COVERED IN SINGLE REPORTS

Since it is inevitable and proper that the treatment methods in any disease should evolve and progress, statistical reports on groups of cases ranging over periods of 10 to 20 years can be of little practical interest, except in the study of the clinical course of the more rare diseases. Most reports covering such long intervals serve mainly to emphasize the personal achievements of a single individual or of one institution, and as such, have a historic rather than a practical significance.

A report of end-results is of little more than academic interest unless the patients upon whom the statistics are computed were all treated within a definite, limited time period, preferably short, so as to cover no more than a 5 to 10 year interval. To be of timely interest, the end-report had best be made immediately following the completion of a 5 year observation for the whole group; as for instance, a series of patients treated during the several years immediately preceding 1930 should be reported in 1935, etc.

The grouping of cases treated over longer periods in one report suggests a static rather than a progressive attitude toward the cancer problem. For these reasons, it has been made the policy in our clinic to limit statistical reports to groups of cases in which patients were treated over shorter periods (about 5 years) so that in the future, one may have a standard with which to compare the actual value of any subsequent development or improvement in technique.

[1]The general acceptance of a 5 year period as being necessary for cure is comparatively recent. Until well past the middle of the nineteenth century, the cancer patient was commonly spoken of as "cured" if he survived the surgical operation, although even at that time recurrences had been recorded as late as 3 years after operation. Butlin, in the first edition of his *Diseases of the Tongue* (1885), calls attention to the inadequacy of the less than a year's freedom from disease for cure in cancer of the tongue, while in his second edition (1900), he speaks of a 3 year period as being generally accepted. Up until the second decade of the twentieth century, a 3 year period was considered ample, and even today, one finds numerous reports of 3 year cures in the literature.

COLLECTED AND SELECTED CLINICAL MATERIAL

To be fully informative, a series of cases used for statistical purposes should be unselected—that is, it should be made up of all patients in any and all stages of the disease who have been observed within a specified period. The cases must therefore be consecutive and collected, rather than scattered and selected. The selection of cases on the basis of operability or probable curability renders a report of the end-results of limited value, since there can be no uniformity of individual opinion as to what constitutes operability or curability, and it is obviously difficult, if not impossible, to avoid a personal bias in choosing mainly those cases which will favor the operator. One must admit that an astute and experienced surgeon could deliberately select a group of patients even with as lethal a disease as cancer of the tongue in whom he could obtain an almost perfect percentage of cures.

The aphorism "The physician sometimes cures, often relieves, and always consoles" finds no greater field of application than in cancer. It is of little interest or benefit to the patient already suffering from cancer to be informed that early or operable or otherwise favorable cases of his disease may be cured in a high percentage of instances. What he wishes to know is whether or not *his case* may be cured or benefited, and what methods of treatment offer him the most likely relief.

In the head and neck clinic at Memorial Hospital, all ambulatory cases of intra-oral cancer, both primary and recurrent, are accepted for treatment or palliation, and are attended as long as they are able to travel to and from the clinic. No patient is refused admission to the clinic because of the advanced stage of the disease. In some instances, patients apply at the clinic in the early stages of the disease, but are unable because of some unrelated form of physical disability or because they live at too great a distance from the clinic to return as often as would be necessary for adequate treatment. Such patients must be refused as being inacceptable for admission. Few are excluded for these reasons, however, since most patients with intra-oral cancer remain ambulatory almost to the end.

TABLE I.—MEMORIAL HOSPITAL HEAD AND NECK SERVICE 5 YEAR END-RESULTS IN INTRA-ORAL CANCER

	All cases of cancer of the tongue, 1927–1931, inclusive	All cases of cancer of the lip, 1928–1932, inclusive	All cases of cancer of the cheek, 1925–1929, inclusive
Total number of cases	322	251	99
Indeterminate group			
Dead as a result of other causes and without recurrence	27	29	5
Lost track of without recurrence	5	34*	3
Total number of indeterminate results	32	63	8
Determinate group			
Total number minus those of indeterminate group	290	188	91
Failures			
Dead as a result of cancer	215	58	59
Lost track of with disease (probably dead)	0	0	3
Living with recurrence	1	0	1
Total number of failures in treatment	216	58	63
Successful results (Free from disease after 5 years or more)	74	130	28
Five year end-results (Successful results(/)Determinate group)	26% (74/290)	69% (130/188)	30% (28/91)

*(Further follow-up is being carried out, and the percentage of 5 year cures [69%] will undoubtedly be raised).

These groups consist of all proved cases of cancer of the tongue, lip, and cheek, both early and advanced, in which patients were admitted during the specified periods. (Only those patients are excluded who made no more than one or two visits and who were then lost track of within the first month.)

The groups of cases presented in this report are made up of all comers and are consecutive and collected rather than scattered and selected. For these reasons, this report should represent the actual results which may be obtained in a true cross-section of intra-oral cancer, as it exists today in a large metropolitan center.

THE INFLUENCE OF UNCONTROLLABLE FACTORS ON THE APPARENT CURE RATE

If one could exclude every other modifying influence except cancer for a full 5 year period, the percentage of cures should properly be calculated on the total of all cases without any subtractions. But as will be shown, there are several factors influencing the apparent percentage of cures which are beyond the control of the surgeon, and which are not affected by the efficacy of his treatment. These uncontrollable factors are, first, deaths from other causes unrelated to cancer; second, the inability to trace certain apparently cured patients for the full 5 year period (these two make up the indeterminate group), and third, failure of the patient to accept the proffered treatment. None of these minority groups can be fairly counted either for or against the percentage of cures. Each of these factors will be discussed separately.

1. *The indeterminate group* consists of patients dead from unrelated causes and those without recurrence who are untraced for the full 5 year period. If following clinical disappearance of the cancer and without recurrence, the patient dies within the 5 year period of unrelated causes (heart disease, old age, accident, etc.) not incident to, or as a complication of, treatment, the case may not be fairly counted as either a cure or a failure. Those lost track of after 1 year without recurrence are also indeterminate, and not fairly counted either for or against the percentage of cures. Both of these groups may fairly be subtracted from the total before the net percentage of cures is calculated. To count either of these groups as failures to cure is, in my opinion, an ostentatious gesture toward a precision which serves only to obscure the more important facts relating to the efficacy of treatment.

2. *Failure to complete the treatment once begun* is frequently due to some defect in the method itself which makes it unacceptable or intolerable to the patient. In such instances, the failure to manage the patient may be the fault of the surgeon or the method of treatment, and as such, should be counted against the percentage of cures. It is reasonable, however, that one should exclude those patients

TABLE II.—FACTORS INFLUENCING THE PROGNOSIS IN 322 CASES OF CANCER OF THE TONGUE OBSERVED AT THE MEMORIAL HOSPITAL 1927–1931

	Total number of cases	Number of 5 year cures	Per cent of 5 year cures
Age in years			
Below 40	23	9	39
41 to 50	48	16	33
51 to 60	120	26	21
Over 60	131	23	16
Sex			
Males	276	48	18
Females	46	16	35
Stage of disease			
"Operable"	90	50	55
"Borderline"	42	18	42
"Inoperable"	190	10	5
Position of growth			
Anterior third	47	13	27
Middle third	180	53	29
Posterior third	95	8	8
Metastases			
None at any time	125	51	40
Present on admission	113	6	5
Developed after admission	84	19	22
Histopathology			
Epidermoid carcinoma, Grade I	51	23	45
Epidermoid carcinoma, Grade II	177	35	25
Epidermoid carcinoma, Grade III	23	1	4
Lympho-epithelioma	2	0	0
Transitional cell carcinoma	14	2	14
Adenocarcinoma	5	0	0
Not classified*	50	13	26
Associated leucoplacia	69	26	37
Associated syphilis	70	14	20

*Biopsy positive but unsatisfactory for exact classification.

who belong to the well known class of "clinic shoppers" and who go from clinic to clinic, sometimes trying out a treatment or two in each. Such individuals characteristically make only one or two visits and then disappear. There have been excluded from these series for this reason those who were lost track of during the first month after making no more than two or three visits to the clinic.

NET 5 YEAR END-RESULTS IN CANCER OF THE TONGUE, LIP, AND CHEEK

Using these standards for the determination of groups of cases upon which to calculate statistics, there is presented in Table I the 5 year end-results in the main anatomical varieties of intra-oral cancer at the Memorial Hospital. Our treatment methods in all of these diseases either have been or are soon to be published elsewhere (1, 2, 3).

In the choice of treatment methods, we are not influenced by any attempt to prove the superiority of either radiation or surgery. Our staff is composed entirely of surgeons who select, prescribe, and administer radium, x-ray, or surgery, either alone or in various combinations of two or all three in the individual case, depending on the particular advantages and limitations of each agent. The particular form of treatment for the individual case is selected first on the basis of its probable success in obtaining a permanent cure with reasonable comfort. Secondary considerations of importance are the functional and cosmetic result, the length of the convalescent period and the expediency of the proposed plan.

As the surgeon becomes more proficient in the use of radiation, either alone or in combination with surgery, the term "inoperability" becomes less and less synonymous with "incurability," and on the other hand, "radioresistance" does not necessarily preclude an excellent prognosis by surgery.

I believe that some uniform method of reporting end-results in cancer should be adopted officially by some influential national surgical organization or publication. If so recognized, its general adoption would soon follow. It is not sufficient to settle upon a uniform observation period, such as the generally accepted 5 year interval. If no uniform method of collection or selection of cases is established, the percentage of 5 year cures may be calculated on any one of such arbitrarily chosen portions of the whole group that the statistician may obtain a wide selection of 5 year cure percentages. A reference to Table II which is an analysis of the same series of lingual cases cited in Table I, will reveal that by selecting only the "operable" group (a not uncommon procedure in reporting end-results), one could claim a 5 year cure rate of 55 per cent in cancer of the tongue, which is more than double the correct figure (26 per cent) for the whole group as shown in Table I. By selecting only those without metastases, a 40 per cent cure rate is obtained. It would be no more illogical to select only the age group under 40—39 per cent—or only the females—35 per cent—than to calculate end-result percentages on the operable group alone.

Even a cursory survey of the present day

medical literature will reveal reports based on cases selected because of "operability," "absence of metastases," "primary lesion less than two centimeters in diameter," etc. These highly selective groups are commonly chosen by both the partisan surgeon and the partisan radiologist to emphasize the advantages of his particular method of treatment. While he may be perfectly correct in his attitude toward one particular subgroup, a broader view demands a consideration of all cases in any and all stages of the disease. Viewed with this broader concept, such subclassifications as "operability" and "presence of metastases" assume an equal significance with "age," "sex," "histological form," etc. In other words, all subdivisions or subgroupings become "factors influencing the prognosis." Strictly speaking, no figure so calculated may be interpreted as an "end-result."

The form set down in Table I is submitted as a reasonable method of calculating 5 year end-results in cancer. It could just as fairly be used to express the end-results in measles or appendicitis. The table begins with the designation of the total number of cases seen during a specified time, and specifies that none were excluded on the basis of the advanced stage of the disease. Next follows an enumeration of the "Indeterminate group," which consists of those dead of other causes without recurrence after 1 year and those lost track of without disease after 1 year. This indeterminate group is subtracted from the total, leaving a net or "determinate group" upon which the end-results may be calculated. Next come the "failures in treatment," which include first those dead of cancer, those lost track of with disease (including those who did not complete the treatment), and those who are living after 5 years with recurrence. The difference between the determinate group and the failures is made up by those cases in which patients are living and well after observation for 5 years or more. The net end-results are then calculated by the percentage expressed by the equation—living and free of disease after 5 years (/) determinate group. If the surgeon wishes to record the cure rates in the various selected subgroups of the total, those data should be set down in a prognosis table, as is shown in Table II. The extent of such an analysis may vary, depending upon the information available and upon the probable significance of the factors influencing the prognosis in the specific anatomic form of cancer under consideration. While such data are of great significance and importance in the study of the clinical behavior and of the treatment methods in cancer, they cannot properly be considered as end-results.

SUMMARY AND CONCLUSIONS

From published statistical data, it is often difficult or impossible to evaluate properly the comparative merits of contemporary treatment methods in cancer because of the wide differences in the make-up of the clinical material upon which the reports of cure rate statistics are calculated. The most misleading forms of reports are those based upon the arbitrary selection of early, "operable" (those operated upon) or otherwise favorable cases, rather than upon all comers in all stages of the disease, both the early and favorable, and those hopelessly advanced. Other difficulties are the lack of uniformity in the length of the post-treatment observation interval in various reports, the scattered rather than the consecutive character of the clinical material, and the inclusion in single reports of cases in which patients were treated over too long periods, during which period the treatment methods may have undergone marked changes.

There is a need for a uniform tabular method for reporting of end-results which would overcome these inconsistencies. Such a method should largely prevent the arbitrary selection of clinical material and still permit certain corrections for uncontrollable factors. Based upon these principals, a method or form is suggested with a report of the net percentages of 5 year end-results in cancer of the tongue, lip, and cheek at Memorial Hospital.

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ILEOCECAL LYMPHADENITIS IN CHILDREN

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IT IS now generally recognized that there exists in children and young adolescents, an acute abdominal condition, in which the symptoms are very similar to those of appendicitis, but in which the predominant findings at operation, and presumably the principal pathological basis, consist only of an inflammatory enlargement of the mesenteric and retroperitoneal lymph glands draining from the ileocecal angle. The condition is common, and owing to its resemblance to appendicitis most cases come under the direct observation of surgeons. Nearly always the pre-operative diagnosis made is appendicitis. Admitting that the clinical picture seen in the two conditions is very similar, my own experience with cases of ileocecal adenitis teaches me that with care and a knowledge of the condition a correct pre-operative diagnosis is possible in at least a reasonable proportion of cases.

The general picture of such a case is as follows: The patient is between the ages of 3 and 18 years. He is seized with abdominal pain which is of varying severity and can generally be traced to the right lower abdomen. During the attack there is evidence of definite toxicity. The attacks subside as a rule, and the child has intervals of weeks or months during which he is apparently perfectly well; but the attacks recur and will continue to recur, until the operation of appendicectomy is performed, after which he will be free from symptoms. In English the standard and probably best known descriptions of the condition are those of Fraser in his book *The Surgery of Childhood*, and of Braithwaite in the *British Journal of Surgery* of 1925.

Fraser writes of it, "There is considerable general disturbance and fever. The symptoms rarely last for more than 24 to 48 hours and abate with characteristic suddenness. The pain is local from the start, never referred. The tongue remains clean." And he emphasizes a little later, "The attack subsides with characteristic rapidity."

Braithwaite divides the cases for the purposes of description into three age groups. In children from 2 to 6 years old, his description closely agrees with that of Fraser. Of the symptoms in children aged from 6 to 10 years he says: "They are typified by acute attacks of sudden abdominal pain suggestive of intestinal colic. . . . With the onset of the pain the child cries out, holds its belly with both hands, draws up its legs, and in 10 minutes is perfectly fit and well. Occasionally there is vomiting, more rarely there is a passing rise of temperature to 100 degrees F. The child though appearing in pain during the attack is perfectly well after it and before it. There may be two or three attacks during the day, or there may be intervals of months between the attacks." He classes children aged from 10 to 16 years in a third group, in which he says ileocecal adenitis does not usually occur.

It will be noticed that there is a very considerable difference between these two descriptions. I propose to set out a small series of cases of my own, in most of which reasonably careful histories and records have been taken. It will be seen that the clinical analysis of them does not bring them into close agreement with either of the two descriptions quoted.

CLASSIFICATION

I am grouping them for convenience into two main groups, of which Group A comprises those of the more acute type, which closely simulate acute appendicitis, and in which one operates urgently expecting to find a grossly and acutely inflamed appendix. Group B comprises those cases in which the general picture is that of a milder or recurrent type of symptom complex, in which the need to operate does not appear so urgent, and in which the operation is usually performed in the expectation of finding a "subsiding" or "chronic" appendicitis. Necessarily the difference between the two groups is one of degree only, and the distinction is not very clear cut. I propose to illustrate each group by set-

ting out a typical case history in full, before proceeding to a full analysis of the general clinical picture.

Group A. Acute cases. This group consists of 7 cases, of which 3 are atypical, in that they are all three members of one family, all attacked within a week of each other, and showed gross edema of the cecal or colonic wall in addition to the glands. These 3 cases must have owed their origin to some common infection of an alimentary nature, and although they must be brought into the group of more acute ileocecal adenitis, I regard them as forming a class apart from the others. The 4 other cases were patients suffering from acute symptoms in whom at operation no major pathological changes were found in organs other than the glands. They closely simulate acute appendicitis, and the patients are generally operated upon under that diagnosis. There is often a palpable mass, and the condition is obviously one of a very acute infection. The following case is typical of the class:

CASE 17. Frank A., aged 14 years, male. First symptoms occurred 6 days prior to examination, when he became ill with what his parents described as "influenza." He was feverish for 2 days, immediately after which he had severe abdominal pains with fairly severe retching. The pains persisted, being more or less severe in degree, and were said to be definitely worse after taking food. The day before examination he had an attack of shivering, and that evening the pain became localized in the lower right side of the abdomen. His bowels were described as being "inclined to constipation." During the past 2 years he had had repeated attacks of general abdominal pain, these being less in evidence during the past 12 months. On examination: tongue was found to be dry and dirty; the temperature, 102 degrees; pulse, 112; respirations, 20; leucocytosis, 18,000. The abdomen was flat. There was tenderness in the right iliac region, overlying a tender mass felt beneath the abdominal wall. The mass was dull to percussion, and lay higher and rather more internally than the usual position of an appendiceal abscess. The urine showed a cloud of albumin. A diagnosis was made of ileocecal adenitis, and operation was withheld for a period of observation. The blood picture on the succeeding 4 days is shown in the table which follows.

Date	Leucocytes	Metamyelocytes	Polymorphonuclears	(% band forms)	Eosinophils	Basophils	Lymphocytes	Monocytes
October 20	18000		73	44	0.5		22.5	3.5
October 21	14200	0.5	57.5	35	1.5		37.5	1
October 22	9000	1.5	64	35	2	0.5	26	6
October 23	11000		66.3	48	2		24.3	5.3

On the fourth day the mass felt appeared to be more extensive in an upward direction, and his temperature was 103.2 degrees. Operation was then performed. The appendix was normal in appearance, though with a slight degree of congestion in the serosa. It was neither inflamed nor edematous. There was a large mass of retroperitoneal glands acutely inflamed, the largest and reddest being in the ileocecal angle, smaller and less inflamed along the common iliac vessels and toward the root of the mesentery, becoming smaller as they went centrally. The temperature became normal within 24 hours of the operation and remained so. The albumin disappeared from the urine, and 6 days after the operation the blood picture was:

Leucocytes	12800
Metamyelocytes	.....
Polymorphonuclears	57.5
(% band forms)	13.5
Eosinophils	4.5
Basophils	.....
Lymphocytes	33
Monocytes	5

His health has been uniformly good since the operation, with no attacks of pain.

Group B. Subacute or recurrent cases. These are much the more common type, and 23 of the 30 cases discussed belong to this group. The difference is one of degree only, and individual cases of one group may verge on the characteristics of the other; but on the whole the clinical distinction between the two is sufficiently real to justify the division. The following case may be presented as being characteristic.

CASE 21. George P., aged 13 years, male. First symptom appeared 2 days before examination. The boy had an attack of pain in the abdomen in the afternoon while going to work. He did not vomit, but felt sick. He had his evening meal, and slept well all that night. Pain was still present next morning, and he stayed away from school, but had all his meals. There was an interval at mid day free from pains, but they recurred in the afternoon. He slept all night, but found the pains still present on waking the following morning. The bowels were open normally throughout. The pain was always located below and to the right of the navel. In the previous 6 months there had been three attacks of pain similar in nature, and lasting from half a day to a day. On examination, the tongue was found

to be dirty; the temperature was 99.6 degrees; pulse, 112; respiration rate, 20. The urine showed no abnormalities. Blood examination showed a leucocyte count of 20,800, the differential count being: polymorphonuclear leucocytes 44.5 per cent and mature in type; eosinophils, 6.5; lymphocytes, 46; monocytes, 3 per cent. The abdomen was tender just below and to the right of the umbilicus, not at McBurney's point. There was no rigidity, but a feeling of slight mass under the pressure of the fingers. A diagnosis of ileocecal adenitis was made, and operation fixed for the following day. On the next morning the blood count was repeated, and showed a strikingly different picture. The total leucocyte count was 29,600, with 86 per cent polymorphonuclear cells, well matured, and only 10.5 per cent lymphocytes. The eosinophils had disappeared altogether. At the operation, the appendix was found to be large and bulky, with some congestion in its appearance, but neither edematous nor inflamed. The retrocecal glands of the ileocecal angle, those of the meso-appendix, and those in the mesentery of the terminal 6 inches of the ileum, were enlarged and hard, but quite discrete. The temperature fell to normal immediately following the operation and remained at a normal level throughout a normal convalescence. He has had no recurrence of his intermittent pains since his operation.

FREQUENCY

The cases are all from my own practice in a country district. The period covered by the series is 13 years, from 1922 to 1935, and during that time there have been 159 cases of young people under the age of 19 operated on for symptoms in the lower right side of the abdomen, suggestive of appendiceal trouble. Of these, 30, or 18.9 per cent, of the patients have been proved by operation to have been suffering from acute or subacute ileocecal adenitis.

Of the 159 patients operated upon, 79 had symptoms indicative of an acute and menacing inflammatory condition; and of these, 72 were found at operation to have an acute and grossly inflamed appendix; while 7, or 9 per cent, were suffering from acute inflammatory swelling of the glands.

Patients with milder and recurrent symptoms numbered 80, of whom 57 included all appendiceal cases other than the acute ones, comprising "mildly inflamed," "kinks," "adhesions," interval cases, and so forth. Twenty-three of these patients revealed swollen ileocecal glands as the principal pathological finding.

TABLE I.—AGE AND SEX INCIDENCE OF ADENITIS COMPARATIVELY TO APPENDICITIS

Age period	Acute appendicitis			Other appendicitis			Ileocecal adenitis		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1– 3	1		1						
4– 5	4	2	6	1	1	2	2	1	3
6– 8	3	2	5		1	1	3	4	7
9–11	2	6	8	1	2	3	5	1	6
12–14	14	8	22	4	16	20	5	1	6
15–19	14	16	30	8	23	31	4	4	8
	38	34	72	14	43	57	19	11	30

SEX

The sex incidence in these recurrent cases of adenitis is strikingly different from that of "chronic appendicitis." Among the latter in my series, 14 were in males and 43 in females; while of the adenitis cases 13 occurred in boys, and 10 in girls. The figures are too small to mean much, but such as they are they do help to emphasize the existence of adenitis as a separate entity. The incidence of right iliac pains in adolescent girls, for which at operation it is difficult to assign a reasonable cause, is notorious. If boys alone are taken in this respect, the occurrence of adenitis as compared with that of chronic appendicitis is apparently equal, 13 to 14; while in girls the similar comparison shows 10 adenitis to 43 "chronic appendicitis."

CLINICAL CHARACTERISTICS

Age. The youngest child operated upon was 2½ years old; the oldest 19. Another girl was 19 when operated on, but she had had repeated attacks since the age of 12. In general the age of these patients at the time at which they come under the observation of the surgeon may be anywhere from 3 to 18. Table I shows the age incidence in successive three year periods.

Previous history. Fifteen of the 30 cases gave a definite history of previous attacks, going back as far as 7 years in 1 case, 4 years in 2, 3 years and 2 years in others. All the attacks were described as being similar to the one for which operation was eventually performed. In all of them the health of the chil-

dren between the attacks was stated to be absolutely normal. The intervals were from a week up to 12 months in various cases, and the frequency of the attacks varied greatly in any one case. Two other cases reported almost constant but remittent pains in the abdomen for 5 or 6 weeks before being seen. The 13 remaining, including 5 of the 7 acute cases, were operated upon during or following their first attack.

Duration of attacks. The acute group of cases showed no sign of remission of their symptoms up to the time of operation. The longest time between the onset of symptoms and the performance of the operation was 11 days, the shortest 2 days. In the recurrent cases, the duration of the attacks was in some instances determined by actual observation; but for the most part had to be ascertained from the child's mother. There is a wide variation in the duration, from 10 minutes as in Case 15, to 2 days in many cases. As a rule the duration of the attacks may be taken as being 1 or 2 days, and gradual subsidence was the rule.

Accompanying bowel disorders. Of the 26 cases in which the condition of the bowels has been recorded, 22 are said to have been regular and normal up to and during the attack. Two were said to be inclined to constipation generally. One had an attack of diarrhea on the fifth day after the onset of pain, but normal evacuations until then. And one passed a "green slimy motion" on the morning of onset.

Vomiting. The occurrence of vomiting is noted in 8 cases only, in 3 being severe with constant retching, and in the 5 others a single vomit only. In 17 cases it did not occur, and in 5 the record fails to report on it.

Toxemia. In all those 4 acute cases which followed the typical adenitis course and did not show gross bowel wall changes, general toxemic symptoms precedent to the onset of pain were very marked. In one case it was described as "influenza," in another tonsillitis, in a third "drowsy and feverish" while the fourth spoke of "feeling sick" for some time before he felt any pain. The child who considered he had tonsillitis, said he had had it for 5 days before pain.

Of the 23 recurrent cases, 8 gave a definite history of precedent symptoms of general toxemia, varying in description from dizziness to headache and delirium. Four showed evidences of general toxicity during the attack, 1 being jaundiced, and 1 having albuminuria. Two had only very mild evidence of toxemia, and in 9 it was either absent, or not recorded.

Location of pain. The statement that pain in adenitis is "always local, never referred" is not borne out in any sense in my experience. In 11 of these patients there was a later localization of the pain following earlier generalized pains which were impartially general, upper abdominal, or left sided in position. Four reported general colic-like pains without any later localization. In 7 the pain commenced in the right lower abdominal quadrant, and remained there throughout. In 2 the pain remained referred to the upper abdomen all through the attack, and in 2 it remained localized around the umbilicus. In 4 cases the exact localization of the pain was not recorded.

Location of tenderness. In this respect unfortunately my earlier notes are not as exact as they should have been. Too many of them report the tenderness roughly as "right lower abdomen" or "appendiceal region." Eleven cases are noted as having the point of maximum tenderness in the right iliac region, and two as "at McBurney's point," which latter term, in the loose sense in which it is used is probably about equal to "right iliac" in definiteness. In 2 cases the maximum point of tenderness was not specified. Thirteen, however, of the later cases have definite notes recorded, and of these, 3 are marked as "internal to McBurney's point," 1 definitely at McBurney's point, 2 higher than this point, 5 "just below and to right of the umbilicus," and 2 as "just below the umbilicus and both to right and left of it." In 1 case (Case 15), one of the earlier attacks which I personally observed gave a point of maximum tenderness just below and to the left of the umbilicus, while on the next attack, it was just below and to the right of it. Further experience and more careful examination with regard to this in particular, make me feel sure that in nearly all of the 12 first cases, more careful recording

would have demonstrated tenderness at a definite point, differing from that at which the tenderness of appendicitis is usually felt, and that this is a point of decided importance in making a diagnosis.

Rigidity. In 5 cases rigidity is reported in the right iliac region, and 3 are marked down as doubtful in regard to rigidity. The 22 others had definitely no rigidity of the muscles over the inflamed glands. All those in which rigidity was definitely present were of the acute type; and the absence of rigidity is a point in favor of the diagnosis of adenitis.

Palpable mass. The gland masses were palpable through the abdominal wall in only 3 cases, all of the acute type. A mass is not necessarily to be looked for in adenitis, and this is readily understandable when the glands are seen at the operation. It requires a considerable swelling of them, and some conglomeration of the individual glands together, to make them readily palpable without an anesthetic. When it is felt, its position is as a rule higher in the abdomen than is that usually presented by an inflamed mass of appendix and omentum. This point assisted me in arriving at a correct diagnosis in one case.

Tongue. In 12 of these cases the tongue was described as "dirty." In the others this point was not noticeable. In general the tongue is that of a mild condition.

Temperature and pulse. The same may be said of the temperature. In 20 of my cases it was below 100 degrees throughout. In only 4 did it exceed 102 degrees, and only twice did it pass 103 degrees. Evidence of marked intoxication is not shown by the tongue, or by the temperature except in the more acute type of case. The pulse corresponds in nature. Only in 11 cases did the rate rise above 100, and in none of these above 120.

Leucocytosis. Examinations of the white blood cells give the same picture of a fairly mild general infection. Counts were made in 14 of my cases, and the results were very largely variable. Thus 1 case showed 20,000 leucocytes on one day, and 29,600 on the next. Another case recorded 16,600 per cubic millimeter one day, and 30,600 the next. In general one expects a count of somewhere about 20,000, with approximately 70 per cent of neutrophils and these of mature type. In 1 case (Case 17), while the leucocyte and the total neutrophil counts remained steady, there was a persistent increase in the percentage of immature and "band" forms of polymorphonuclears. This has not been common in the less acute type of the disease. Eosinophil counts of 9, 10, and 17 per cent have been noticed, but on one of these being repeated next day, all eosinophils had vanished from the fields counted. The leucocyte count in these cases would seem to be of no value in diagnosis, other than in supplying evidence of a certain degree of toxemia without offering any indication as to the specific cause.

OPERATIVE FINDINGS

Appendix. The appendix is never found to show pathological changes comparable to those in the glands that drain from it. The reports on the appendices removed in this series vary from "normal" without comment, to "mildly inflamed" or some other similar term. It is noticeable that the term "long and bulky" occurs rather often in the descriptions; but as these cases are all children, in whom the appendix is usually rather larger relatively than it is in adults, the significance of the description is somewhat doubtful. Reddening of the serosa to a mild degree is seen in about half the cases. The mucosa is most often normal to the naked eye. The contents are mainly semifluid feces, in a few cases stercoliths. Microscopic examination of the appendix wall, which has been carried out in only a few of the cases, discloses only a normal, or slightly congested organ. In an endeavor to support a supposition that the reddening of the appendix seen, represents only a residual inflammatory condition, and that the organ as seen is in a subsiding condition after having been inflamed, and having infected the glands; I divided the cases into those operated on less than 3 days from the onset of symptoms and those of longer duration. I found no support for the theory. Cases of 10, 11, and even 30 days' duration showed the slight reddening in just the same proportion of their total number, as did those seen on the first or second day of the attack. In 1 case in which the

diagnosis had been made and operation had been deferred deliberately until 9 days after the subsidence of the symptoms, the reddening of the lower ileum, cecum, and appendix was as definite as in any I have seen. In no case was there anything remotely approaching an acute inflammation of the appendix.

Lower ileum. This was in a few cases described as slightly reddened, along with the appendix. In about half the cases its condition was not specially mentioned; in the rest it is stated to be normal in appearance.

Cecum and colon. In 2 acute cases recorded above as of a special type of acute case, and in which the patients were operated on, there was swelling, presumably inflammatory in the cecum and colon. No change in the appearance of these organs is otherwise noted.

Peritoneum. Occasionally a small amount of free fluid was noticed in the peritoneal cavity. It was never great, and may on other occasions have escaped my notice. The peritoneum itself seemed to take very little part in the inflammatory process occurring in the glands underlying it. Only in the 2 acute cases mentioned, with swelling in the bowel wall, was edema of the peritoneum or of the meso-appendix noticed. This is in rather striking contrast to the edema of the meso-appendix seen so frequently in cases of acute appendicitis. The peritoneum is usually stretched loosely over the glands, and is not even conspicuously reddened, which fact has probably a bearing on the fact that absence of rigidity of the abdominal wall is such a constant feature of adenitis cases. Apart from the slight reddening sometimes seen in the serous coat of the appendix and lower ileum, the peritoneum appears to take no part in the pathological picture.

Glands. In these lay practically the whole of the pathological changes grossly visible. The situation of the glands found to be affected in this series was as follows:

Ileocecal angle and meso-appendix	25
Inner border of cecum	5
Along the right common iliac vessels	3
In the root of the mesentery	6
In the mesentery of the lower ileum	7
In the angle between the two common iliac arteries	1

In every case, the glands were large enough to be immediately felt by the exploring finger. In general when discrete they were about the size of a French bean. In color they were a light tone of liver color, or a reddish pink. Except in those cases in which they had fused into a conglomerate mass, they were readily movable under their peritoneal covering, and on this covering being incised they readily extruded. On section of their capsule the gland substance, pinkish in color, bulged out. Microscopic section of several of them revealed nothing more than a lymphoid concentration of round cells; and cultures of the scrapings taken from two of them *in situ* and cultured on agar, failed to produce any growth.

CLINICAL COURSE OF THE DISEASE

Since the positive diagnosis of adenitis is confirmed only by operation, all reported cases are shown as terminating by operation. It is possible that many other patients suffering from such swelling of the glands have less severe or less frequent attacks, and not being operated upon, never get into the records of adenitis cases. I have among my own records a number of cases of children in whom I have diagnosed adenitis recently and left for further observation. But, the diagnosis not having been proved, they cannot come under discussion here. Country practice, however, affords excellent opportunities for prolonged observation, and I have been able to watch these patients personally for years both before and after their operations. The course of events is apparently this: A child suffers infection of the glands, evidenced by an attack of pain. In many instances this does not lead the mother to seek medical advice, and it subsides; but having once become infected, the attacks of acute swelling have a definite tendency to recur. The child has one attack after another at varying intervals, until the mother takes it for advice. If the condition looks sufficiently like appendicitis the child is operated upon. If as often happens the picture is not completely like that of appendicitis; if the tenderness has passed off, or is placed round the umbilicus, or even to the left of it, operation is deferred. The attacks are still repeated, and finally the child comes to be operated on, and the appendix is removed.

From that time onward the attacks of pain cease, and the child remains in good health. I have watched one such child for 7 years, others for 3 or 4 or less. And I am firmly of opinion that until the appendix is removed, the attacks will inevitably recur. I have not yet seen a child in whom the attacks of pain recurred once the appendix was removed, and I have been able to follow them all closely for years after operation.

What would happen to the glands if the appendix were not removed it is difficult to say. The nature of the disease, and the conditions for making the diagnosis forbid discussion of the point. Whether the glands would become calcified or whether they would gradually lose their susceptibility to the attacks of inflammation with advancing years is problematical. In 1 patient whom I operated on at the age of 19 years, after 7 years' history of symptoms, the glands were—"some hard and calcified; some caseated; some acutely inflamed and edematous." Other patients operated on after 4 years' known history of repeated attacks, have shown glands no different from those seen in first attacks.

THE RELATIONSHIP OF THE OBSERVED GLAND CHANGES TO THE SYMPTOMS

The relationship of the gland changes to the symptoms is a matter of some little difficulty to satisfy oneself upon. In one group of cases the patient shows a certain group of symptoms, and when operated upon an evidently diseased appendix is removed—here the relation between cause and effect seems clear. In another group of cases very similar symptoms are exhibited, but operation reveals a cluster of acutely inflamed glands, and again the relation between cause and effect seems clear. But there is yet another group of cases with a very similar symptom complex, and operation reveals a normal appendix and normal glands; here the assigning of a cause to the effect is not easy. T. A. Smith, of New York, takes the view that symptoms in this type of case are due to a condition of lymphoid hyperplasia of the appendix, and in the comparatively few cases in which he found glands enlarged he considered them of quite minor importance. My experience leads me to believe that very careful history taking, and a very close examination of the point of maximum tenderness, will enable a differentiation to be made between those cases in which the appendix is the direct cause of the symptoms, and those in which the principal rôle is played by the glands. And, further, that the inflamed glands are the direct exciting cause of the symptoms. The mechanism of the production of these symptoms is probably this: The toxic symptoms accompanying or preceding the pains, indicate the invasion of the body by the infecting organism, by whatever portal it enters. The largely reflex character of the pains and their colic-like nature in the early stages, suggests a reflex bowel spasm due to stimulation of the sympathetics by the development of inflammatory changes probably in the glands or possibly in the ileocecal region of the bowel. And the later localized pain and tenderness are probably due to distention of the capsules of the glands and the immediately surrounding connective tissue. Inflammation of the peritoneum does not appear to play any important part.

PATHOLOGY

By very far the greater part of the discussion on the pathogenesis of inflammatory swellings of the retroperitoneal glands, has hitherto centered round the part which is played in it by the Bacillus tuberculosis. Other interesting questions, such as the portal of entry of the infection, and its nature if not tuberculous, have been very much less debated, though they are receiving more attention of recent years than they did in the past. Ten or 20 years ago, the tuberculous basis of the gland swelling was accepted unquestioned. Braithwaite, in his exhaustive article on the subject, quotes 19 authors, of whom 13 used the word tuberculous in the titles of their papers, and the remainder imply a tuberculous etiology in the text, as does Braithwaite himself. Fraser in *The Surgery of Childhood* describes them as tuberculous glands affected by periodical bacterial invasion from the bowel. The constant tendency of the acute attacks to recur once the glands have been infected, certainly inclines one sympathetically toward this theory. The

main objection that can be brought against it, is the difficulty constantly found in proving any tuberculous infection in the glands. Microscopical examination of them by many workers has repeatedly failed to demonstrate in them any tubercle bacilli, or any tuberculous structure. Strombeck analyzed very thoroughly 348 cases of mesenteric adenitis, of which he considered 308 to be tuberculous, and 40 to be non-tuberculous. His tests included many guinea pig inoculations, but his main reliance was in the appearance of calcification appearing in the glands in later life. He considers that calcification should be detectable by x-ray, in 18 months to 2 years after the infection. I have been able to examine by x-ray, 8 of my patients for this purpose. I have not examined any in whom the operation was less than a year previous, since, though the history may go back much further than that time, there was no calcification apparent at the time of operation, and that time is therefore taken as the starting point. The results of these examinations are set out in Table II.

TABLE II.—ROENTGENOGRAPHIC RE-EXAMINATION OF CASES

Case No.	Time since first symptoms	Time since operation	Result
18	16 mos.	16 mos.	No calcification
6	9 yrs.	9 yrs.	No calcification
14	3 yrs. 9 mos.	3 yrs. 9 mos.	No calcification
16	5 yrs.	4 yrs.	No calcification
15	6 yrs.	1 yr. 9 mos.	No calcification
7	15 yrs.	8 yrs.	Faint vague shadow ? calcification
8	4½ yrs.	4 yrs.	No calcification
12	4 yrs.	4 yrs.	No calcification

The completely negative nature of the results has, I confess, surprised me. The most surprising point about it is the result in Case 7, in which at operation, 7 years after the onset of symptoms, well marked sharp edged calcified glands were found. The shadow in the roentgenogram is very vague and indefinite, and it is quite evident that the hard calcification of the glands no longer exists. Strombeck, in his paper, discusses the possibility of resorption of calcium deposits in abdominal glands and holds that it does occur to some extent. It has unquestionably occurred almost completely in this case, but the bearing of this phenomenon on the value of this serial examination is not great, for 2 reasons. One is that calcium resorption to any great extent is certainly not usual; and the other is that the varying periods after operation at which the examinations were made and the varying periods after onset of symptoms at which the operations were done should eliminate the possibility that the absence of calcification both at operation and on x-ray, could be due to this cause. The suggestion offered by a study of this series of cases is that there is no proof in them of a tuberculous infection as a basis of the condition. Further than that it is probably not wise to go.

The portal of entry of the infection would seem to be the lower ileum and more particularly the appendix. The distribution of the glands found affected, the occasional finding of reddening of the appendix and lower ileum at operation, and most particularly the complete relief of symptoms achieved by removal of the appendix, make it seem almost self-evident. But certain facts need explaining before it is conclusively proved. The slight degree of involvement of the glands of the meso-appendix, in comparison with those in the ileocecal angle and in other places is one of these. Another is the different behavior of the glands in these cases from that in gross acute inflammation of the appendix, in which they are comparatively slightly affected. Influenced by these points, Pribram considers that abdominal adenitis is due to an infection of the body by an organism having a special selective attraction for lymphoid tissue, and regards the tonsils as the main originating focus. He states that he has seen cases in which abdominal pains that have persisted after appendicectomy, have ceased entirely following removal of the tonsils. Nothing I have observed in these adenitis cases inclines me to accept his view, while on the other hand, in one of my cases, the tonsils had been removed a month before the onset of the attack which finally led to operation and cure by appendicectomy. B. Schnitzler explains the peculiar behavior of the glands in these cases on the basis of a delayed infection of

them; the appendix or lower ileum having sustained an infection which has disappeared and left no trace by the time the operation has been performed. As stated, I tried to find some support for this theory by grouping my cases with operation in terms of the duration of symptoms before operation but could find none. It remains the most likely possibility that the condition is caused by an infection with an organism in the ileocecal area, which has a slight local effect, but a marked secondary effect on the glands in the draining area. But the actual pathology and bacteriology of the condition still remain to be worked out almost in their entirety.

SUMMARY

I have presented in this paper a small series of 30 consecutive cases of acute ileocecal adenitis, and have endeavored to show by an analysis of their clinical features that a differential diagnosis between this condition and appendicitis is possible, at least in a reasonable proportion of cases. I have drawn from them the conclusion that if operation is not done the attacks of pain will continue to occur intermittently, but that the removal of the appendix will bring about complete and permanent cure. In a short discussion of the pathology of the condition I have not been able to do more than show that tuberculosis as a basis for it must still be regarded as unproved, and to indicate that very little definite knowledge about the actual etiology exists.

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CLINICAL SURGERY

FROM THE TUMOR CLINIC, MASSACHUSETTS GENERAL HOSPITAL

THE GREENOUGH TECHNIQUE OF RADICAL MASTECTOMY

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THE modern treatment of carcinoma of the breast by radical removal of the breast, both pectoral muscles, and the axillary contents was first carried out and described by Halsted and Willy Meyer. J. C. Warren, of Boston, promptly adopted the new operation, and published a modification based primarily on Meyer's technique of operation. The late Dr. Robert B. Greenough was early associated with Warren in this field of interest, and one of his first publications (1) dealt with an end-result study on cases of carcinoma of the breast. William L. Rodman was also responsive to the teachings of Halsted, Meyer, and Warren, and described a modification of the operative technique employing a transverse axillary incision. Greenough was prompt to recognize the merits of the Rodman operation and adopted it in his practice. He modified Rodman's technique by removing a wider segment of skin between the breast and the axillary transverse incision, and also changed the order in which the various steps of the operation are carried out. The resulting incision about the breast was thus roughly in the shape of an arrow-head (2).

The night before operation the field of operation is shaved and scrubbed with soap and water followed by the application of alcohol, and is covered with a sterile dressing. The field of preparation should extend from the line of the jaw to the umbilicus, and from the opposite anterior axillary line across the front of the chest to the midline of the back. The axilla is shaved and painted with a 25 per cent solution of aluminum chloride to inhibit perspiration, and the skin preparation is carried down the arm to the elbow. When the patient is under the anesthetic, the operative field is painted with half strength (3½ per cent) tincture of iodine, and the arm is wrapped in a sterile towel and placed on an arm board abducted at a right angle from the body. Use of a fairly narrow arm board permits the assistant to stand in the angle between its upper border and the upper end of the table, with draping arranged to exclude the patient's head and the anesthetist from the operative field.

The transverse axillary incision begins at the lower border of the clavicle near its mid point: that is, immediately overlying the apex of the axilla (Fig. 1, inset). Medially the clavicle and first rib run roughly parallel to each other, but as the palpating finger passes laterally the depression can be felt at the lateral border of the subclavius muscle, where the rib begins to turn backward and upward. This depression forms an accurate landmark for the upper end of the incision. From this point the incision courses downward and outward, crossing the free border of the pectoralis major well on the axillary side of the upward prolongation of the breast but below the axillary hair area. Incisions that cross through the axillary hair area are likely to be a nuisance to the patient later. The incision continues to the posterior axillary fold, that is, to the latissimus border, at about the level of the lower end of the scapula. Greenough taught that this incision need not be straight. The first part could run straight downward, then curve outward across the axilla, and again turn downward in the lower part of the axilla. Thus, the upper part of the scar is covered by the shoulder straps of a woman's garments.

This incision is carried only through the skin, and then it is deepened by beveling it outward toward the insertion of the pectoralis major and toward the free border of the latissimus (Fig. 1). The pectoralis major muscle is exposed only near its insertion, for there may be nodes on the anterior surface of the muscle. Near the upper end of the incision, the beveling carries the flap upward to expose the clavicle laterally.

When this axillary flap of skin has been raised completely, the pectoralis major muscle is ex-

This paper was prepared as a tribute to the memory of the late Robert B. Greenough with whom the authors were associated as assistants and junior colleagues over an aggregate period of 18 years.

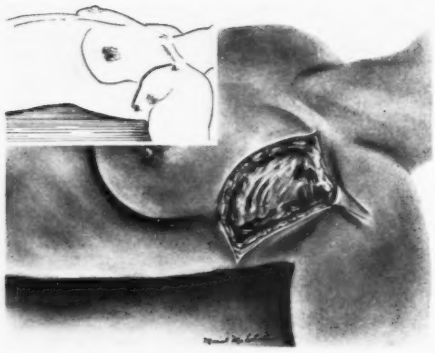

Fig. 1. The transverse axillary incision *A-B* (inset) starts near the mid point of the clavicle and runs downward and outward across the axilla to the posterior axillary fold. The incision is beveled outward to expose the latissimus and pectoralis major muscles near the humeral insertions.

posed from its insertion along a line running roughly to the mid point of the clavicle, and in this region the fibers of the muscle are parallel to the line so exposed. A little above, the cephalic vein can be seen, and it should be spared. The insertion of the pectoralis major is divided close to the humerus and the muscle is split along its fibers up to the clavicle, leaving only a few of the lateral fibers originating from the clavicle (Fig. 2).

At this point in the operation it is necessary to make a further skin incision to give free access to the apex of the axilla. This incision is the upper part of the upper and medial of the two incisions destined to encircle the breast in the shape of an arrow-head (Fig. 2, inset, *D-C*). It starts from a point on the transverse axillary incision near the free border of the pectoralis major muscle, follows this downward and medially toward the breast, and then swings medially toward the sternum around the upper and medial aspect of the breast, to include all the skin overlying the breast tissue. Its exact location varies somewhat with the position of the tumor in the breast. Only the upper part of the incision is necessary at this stage of the operation. The resulting skin flap is beveled back toward the clavicle and sternum, to permit separation of the pectoralis major from the medial half of the clavicle and the upper part of the sternum.

With the pectoralis major muscle drawn downward, a little sharp dissection exposes the upper intercostal muscles and the subclavius muscle, at the border of the tendon of which the axillary vein is encountered as it enters the canal behind the muscle and between the clavicle and the first rib. Exposure of the vein for the first time at this point permits early appraisal of the extent of axillary involvement and provides at least the possibility of retreat if an incorrect estimate of operability has been made.

By means of sharp dissection, the fat and areolar tissue are then freed from the surface of the vein, working distally to the medial border of the pectoralis minor muscle. This muscle is divided near its insertion and retracted downward. As the dissection is carried distally along the vein, the individual branches of the vein are clamped before division and tied at once to avoid undue traction on the vein (Fig. 3). When the lower

Fig. 2. The pectoralis major is divided close to its insertion, and the fibers are split to the clavicle. The origin of the muscle from the clavicle is divided. The skin incision *D-C* (inset) gives greater freedom of access to the apex of the axilla.

Fig. 3. The pectoralis minor is divided near its insertion and the axillary contents stripped away from the axillary vein from the apex outward. Note the free border of the subclavius muscle, marking the apex of the axilla. Note also the cephalic vein lying on the border of the deltoid muscle, and its point of junction with the axillary vein. In the outer axilla the subscapular vessels and thoracodorsal nerve can ordinarily be preserved.

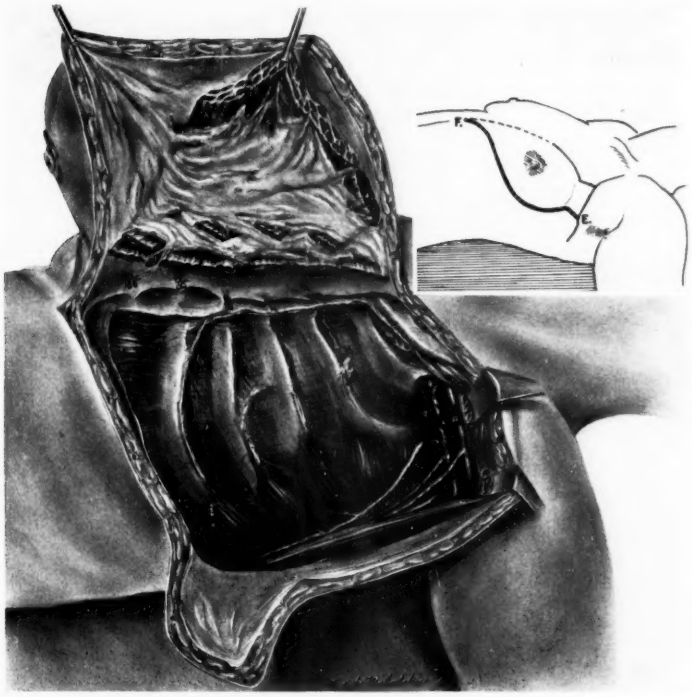

Fig. 4. The incision *E-F* (inset) gives access to the lower axilla, and its contents are carried medially with the breast. The long thoracic nerve is encountered lying on the serratus digitations and is not disturbed. The origins of the pectoralis minor and major muscles are divided close to the chest wall. Note removal of the upper part of the rectus sheath.

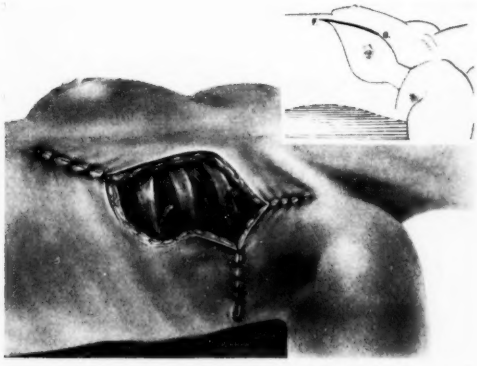

Fig. 5. The specimen is finally freed from the chest wall by the incision *F-G* (inset). Closure is begun at the three corners of the wound. If necessary, a defect may be left on the chest wall to be closed by immediate or deferred skin graft.

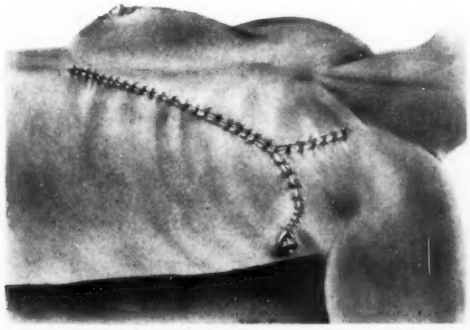

Fig. 6. Closure completed. Drainage may be carried out through the outer angle or through a stab wound. Note the relation of the scar to the axillary hair area. Note also that the infraclavicular scar will be concealed by the shoulder straps of the clothing.

Fig. 7. Postoperative appearance of the patient. Note freedom of the function of the arm and the position of the scar.

border of the axilla is reached, the dissection is carried downward along the free border of the latissimus muscle, moving medially over the teres major and the subscapular muscle to the chest wall. It is usually possible to spare the thoracodorsal nerve to the latissimus and the subscapular vessels accompanying it, but otherwise all the loose areolar tissue in this region is dissected free and retracted medially with the breast. At the chest wall, the upper digitations of the serratus anterior muscle are encountered, and lying on them the long thoracic nerve. A minimum of areolar tissue is left overlying the nerve which is not lifted from its bed,[1] but otherwise the serratus digitations are dissected clean of their overlying fascia.

At this point it is necessary to make another skin incision (Fig. 4, inset, *E-F*). The incision begins at the transverse axillary incision about 2 inches lower than the upper one previously made, and sweeps downward and then inward around the lateral and inferior borders of the breast. This incision like the others is beveled back away from the breast to reach the chest wall well beyond the breast itself. Access is thus secured to the lowest part of the axilla and lowest serratus digitations, which are dissected clean.

The breast and muscles are now lifted and retracted medially, and the muscles are separated from their origins on the chest wall (Fig. 4). When the structures are lifted in this way it is possible to see and secure vessels before dividing them. This maneuver is particularly desirable in dealing with the perforating branches of the internal mammary vessels. At the lower and medial end, more or less of the upper rectus fascia is removed, depending on the location and extent of the primary growth. Dissection beneath the breast in this fashion is carried medially to the mid sternal region or beyond, depending on the location of the primary growth.

When the hemostasis has been secured on the chest wall the breast is allowed to fall back into its normal position, and the skin incision is completed along the medial border of the breast (Fig. 5, inset, *F-G*). This finally frees the entire specimen.

After complete hemostasis, closure is usually effected without great difficulty, due to the wide beveling of the wound and undermining of the skin. The transverse axillary incision is closed from either end. The redundancy of the lateral skin flap, of a length corresponding to the base of the removed arrow-head shaped area of skin on the specimen, is drawn downward and sutured to the upper axillary parts of the two incisions which swept about the breast. Thus these two are brought together and sutured to each other, leaving a linear wound extending to the epigastrium (Fig. 6). Occasionally the tension is too great and a defect must be left to be closed later by granulation or by skin graft.

[1] If the nerve is lifted from its bed the individual branches to the serratus digitations are, of course, destroyed.

GENERAL CONSIDERATIONS

There does not seem to be any very efficient method of applying skin towels to an operative wound of this kind. The best alternative seems to be to make incisions only as they are needed in the course of the operation, and to keep all parts of the wound constantly covered with hot wet packs except for the area actually in process of dissection. This procedure minimizes as much as possible the exposure to infection as well as blood loss, cooling, and drying.

We deplore the use of tenacula and double hooks in retraction on the skin flaps, although it is permissible on the muscles and skin to be removed. Excessive use of toothed forceps on the skin edges is also to be condemned. Smooth retractors, or the hand of the assistant protected with gauze, should be all that is necessary. Dissection should be sharp, either with scissors or knife, and hemostasis should be accurate and exact. In recent years we have frequently used electrocoagulation instead of ligatures on all vessels except the branches of the axillary and subscapular vessels. This method does not appear to give rise to any more serum or reaction in the wound than the ligature. Ligatures should be of fine catgut or silk.

Blood loss in this operation varies within rather wide limits, depending upon the skill of the surgeon; and it is greater in obese patients, in patients with large breasts, and in those with hypertension. In a number of routine determinations, the blood loss ranged from 200 to 800 cubic centimeters. Clamping of vessels before division, scrupulous care in hemostasis, and the use of hot gauze packs on the exposed areas, all conduce to minimize the amount of blood loss.

Drainage was a moot question among the early writers on the subject, and will continue to be. A considerable number of these wounds can be closed safely without drainage. Serum will collect in an appreciable number of these in an amount sufficient to require aspiration, or even repeated aspirations. A Penrose drain brought out at the lower end of the transverse axillary incision, or through a stab wound in the lower skin flap, usually suffices to evacuate the serum that collects immediately after operation, and can be safely removed at the time of the first dressing. A second wick in the epigastric region is sometimes needed in obese patients.

Skin sutures are best interrupted, and we find fine silk satisfactory. Great care should be taken with coaptation of the skin edges, especially in the infraclavicular portion of the wound. Where tension is great, across the middle part of the defect, a few pulley stitches may be necessary. If excessive tension is present, it is better to leave a small area to granulate than to risk devitalization and necrosis of the wound edges by use of heavier suture material in an attempt to secure closure. We have not used primary skin grafts in these cases, but have resorted to secondary thick Thiersch grafts or small deep grafts when the defects were extensive.

At the completion of the operation, pressure should be applied to evacuate all air, serum, and blood from the wound. The dressing should be applied to press the flaps firmly against the chest wall and to obliterate all dead space. The arm should be immobilized, preferably by the use of a second binder, holding the arm close to the side with the forearm free or across the body. There is no question that immobilization of the arm not only minimizes the flow of lymph but also prevents the recreation of axillary dead space beneath the flaps.

The first dressing should be deferred for at least 2 days, and preferably for 4 or 5 days. At this dressing the drain may be removed. At least partial immobilization of the arm should be continued for from 6 to 9 days. Stitches may be removed in a week from parts of the wound where there is no tension, the remainder may be removed in 10 days. Motions of the arm are restored by active use and exercise, and should be free in about 3 weeks. Some sort of protective dressing should be retained for about 2 weeks. As a general rule, the patients are able to resume their usual occupations within a month of the time of the operation.

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DOUBLE PULLEY TRACTION IN THE TREATMENT OF HUMERAL SHAFT FRACTURES

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IT IS evident that the current fashion in the care of fractures is distinctly mechanical. The literature is replete with descriptions of ingenious devices designed to facilitate the reposition and maintenance of bony fragments. To the critical observer, it would appear that the wand of Caduceus is being forsaken for the tool chest of Vulcan.

The use of mechanical appliances for the treatment of fractures is no novelty. A perusal of the Edwin Smith surgical papyrus, which was inscribed before 1500 B.C., makes this quite evident. To account for the present zeal in the exploitation of intricate apparatus, there are two apparent reasons. The first is the widespread custom of evaluating the major aspects of any particular case in terms of the x-ray plate. This attitude places a disproportionate premium on the attainment of roentgenologically accurate reduction. Second, it is now stylish to force ambulation on nearly all fracture patients as early as possible. It is assumed that a shorter hospitalization is attended, in practically all cases, by a more rapid convalescence, minimal disability, and a more complete return to normal. This association, far from being axiomatic, is neither clinically proved nor logically tenable.

The indiscriminate employment of pins, screws, wires, bolts, nails, and their kindred devices has thus brought the problem of man and the machine to traumatic surgery. Are we in danger of losing sight of the individuality of the patient and of the individuality of his particular fracture in a maze of gadgets?

It is, therefore, with a sense of added responsibility that I wish to present an apparatus first used 4 years ago for the treatment of fractures of the shaft of the humerus.[1] My intention is to outline its application, advantages, and limitations in as objective a manner as is possible in clinical exposition.

The appearance of double pulley traction is shown in Figure 1. It is a multiple pulley system directly patterned after Russell traction. It is not so eponymically designated because it functions differently; furthermore, multiple pulley systems were used for fractures 1500 years before Russell, and his name should, therefore, not be used as a generic connotation for all pulley systems; finally, in deference to Dr. Russell, we do not wish to add to the confusingly numerous modifications bearing his name.

From the Surgical Service of the Beekman Street Hospital, New York, New York.

[1]Blum, L. The use of double-pulley traction in the treatment of fractures of the shaft of the humerus. J. Am. M. Ass., 1933, 101: 1953.

DESIGN AND APPLICATION

As can be seen, the patient lies supine with the bed tilted by shock blocks to about 10 degrees off the horizontal to afford countertraction. A Balkan set-up is used to support the pulley frame. This latter can be patterned to a size and shape appropriate to the type of bed and size of the room.

The injured arm is abducted to the desired degree so that the olecranon lies clear of the mattress. A padded sling is apposed to the antecubital region with the elbow joint in extension of 110 to 130 degrees.

The continuous rope leads down from the antecubital sling to the single pulley on the horizontal arm of the frame. From there, it runs up to and around one wheel of the double pulley to the wheel on the hand cage. The rope then leads back to and around the other wheel of the double pulley to suspend the weight.

The frame is simply constructed of wood. Holes are bored at intervals in the vertical and horizontal limbs for the placement of the pulleys. The hand cage is of the ordinary type used for skin traction of the upper extremity, except that it is surmounted by a pulley wheel. It is affixed by moleskin strips applied to the volar and dorsal aspects of the forearm. This leaves the arm fully exposed as it lies on the mattress.

With some practice, the injured extremity can be transferred from emergency traction to the completed arrangement of Figure 1, within 20 minutes.

This apparatus functions on the plan of a parallelogram of forces. In Figure 2, the direct and resultant lines of force are superimposed on a duplicate sketch of Figure 1. There are two

Fig. 1. Double pulley traction.

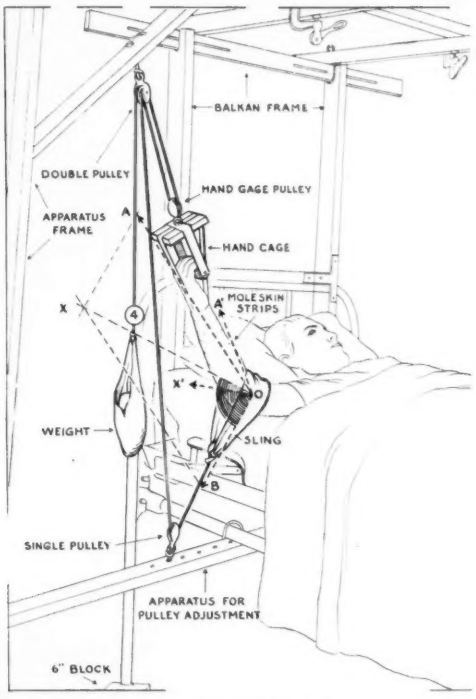

Fig. 2. The mechanics of double pulley traction. *OA*, True double force; *OB*, single force; *OX*, resultant force; *OA'*, apparent double force; *OX'*, axis of fragments.
When *AOB* is a right angle, *XOB* is twice *XOA*.
XOX' (approx. 20°) compensates for:
(1), sinking of patient in bed; (2), sagging and friction of the apparatus; (3), pressure of mattress at the fracture site.

directions of pull. One (*OB*) is downward, running from the elbow in the direction of the single pulley. Its force is transmitted through the cubital cuff and it is equal to the suspended weight.

The other pull (*OA*) is upward, from the elbow toward the double pulley and its force is twice the suspended weight, since this is a double pulley system. The resultant force (*OX*) lies one-third of the intervening angle nearer the greater force (*OA*). This resultant represents the diagonal of the dynamic parallelogram and it is equal to a little more than twice the suspended weight. It constitutes a true axis traction force. Thus, if the weight used were 4 pounds, force *OA* would be 8 pounds, force *OB* would equal 4 pounds, and the resultant *OX* would approximate 9 pounds. Because of the effect of gravity on the forearm and hand cage, the direction of *OA* is taken as 5 degrees lower than the theoretical double force *OA'* which runs from the elbow directly to the double pulley.

In the typical case, the moleskin strips for the hand cage are applied to the forearm before the extremity is removed from emergency traction. This will allow them to become firmly adherent to the skin before any tension is placed on them. thus avoiding the necessity of substitution during the course of treatment. The frame is set at the desired degree of abduction, the rope strung through the pulleys, and the sling put in place.

The initial weight is determined by the muscular development of the individual and by the extent of soft tissue injury. In general, it is advisable not to exceed 5 pounds for men, 4 pounds for women, and 3 pounds for children and adolescents. It has, in fact, been our experience that these are initial, maximal figures and must, as a rule, be reduced sometime during the

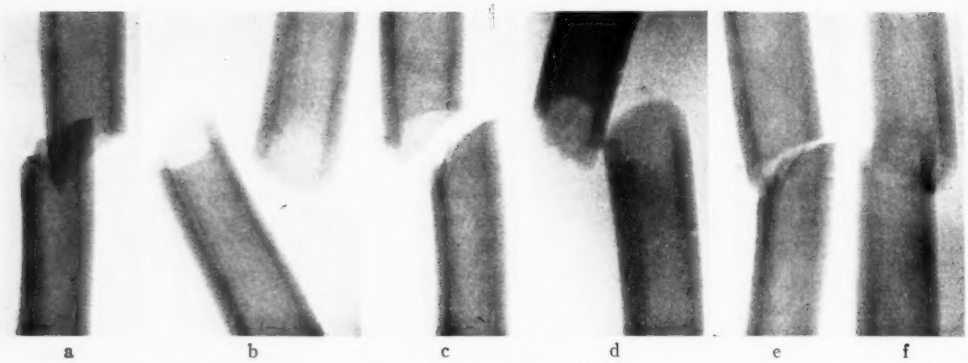

Fig. 3. Case 1. a, Anteroposterior view at 5 hours. Overriding is evident. b, Lateral view at 5 hours. Anterior angulation of 40 degrees. c, Anteroposterior view. Angles adjusted. X-ray film taken at 24 hours. Angulation of 20 degrees, d, Lateral view. e, Anteroposterior view at 48 hours. f, Lateral view.

first week of treatment because of the danger of overpull.

If the plane of the mattress on which the arm rests (*OX'*) is considered to be 180 degrees, then the double pulley should, as a preliminary position, be so placed that the forearm is suspended (double force *OA*) about 50 degrees above the mattress, or at 230 degrees. The single pulley, below, should be adjusted so that the rope leading from the sling (single force *OB*) lies about 40 degrees below the mattress plane, or at 140 degrees. With this initial arrangement, the resultant (*OX*) will be directed about 20 degrees above the mattress (180 degrees) plane (*OX'*), which is, also, the plane of the proximal fragment. In practice, this 20 degrees upward correction has been found to be necessary since the sinking of the patient in the bed, the sagging and friction in the apparatus, and the upward pressure of the mattress at the fracture site all tend so to alter the direction of axis traction.

Anteroposterior and lateral roentgenograms are taken within 12 hours and check up films, thereafter, at indicated intervals. If overriding is present, the problem is one of obtaining sufficient traction over a sufficiently long period of time, since this type of angulation is caused by insufficient pull. It has nothing to do with the angles involved. However, if full length has been obtained and an anterior angulation is present, then an adjustment of the angles to alter the direction of the resultant is necessary.

This is done by first measuring the actual deviation on the roentgenogram with a protractor. The reading in degrees represents the divergence between the working resultant and the desirable one. This discrepancy is then eradicated by appropriate movement of one or both pulleys. Any change in position of the double pulley which affects the direction of force *OA* is twice as effective in changing the direction of the resultant as a similar movement of the single pulley which alters the direction of single force *OB*. The protractor is again employed in this maneuver, by placing its fulcrum at the elbow and directing its arms toward the pulleys to locate *OA* and *OB* and so calculate *OX*. The pulleys can then be moved without disturbing the continuity of traction so as to obtain the desired direction for the resultant *OX*.

In this connection it may be mentioned that when the pulleys are approximated, i.e., when angle *AOB* becomes smaller, the force of the resultant (*OX*) becomes greater and vice versa. However, it has been our custom to move both pulleys when necessary thus leaving angle *AOB* unchanged.

Posterior angulation is rare, occurring once in 24 cases, arising as a result of simultaneous overpull and maladjustment of the angles. Lateral angulation is referable to the degree of abduction and may also be present with slight overriding.

From this description of its proved functions it can be readily appreciated that double pulley traction possesses those mechanical traits which make it an easily adjustable definitive method of obtaining axis traction.

ADVANTAGES AND LIMITATIONS

Our experience with this apparatus has been particularly gratifying because it has revealed that double pulley traction when properly and pertinently used, does work. In short, a discussion of its angles, forces, and resultants does

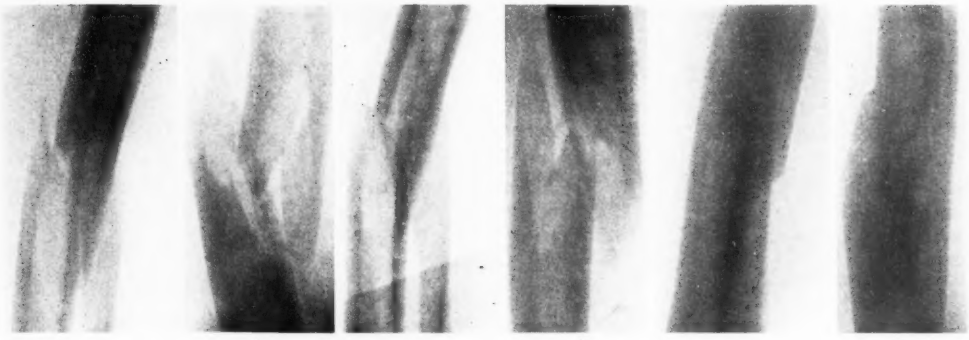

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Fig. 4. Case 2. a, Anteroposterior view. X-ray film taken after 18 hours. b, Lateral view. c, Anteroposterior view. Angles have been adjusted to correct axis. X-ray film taken at 4 weeks. d, Lateral view. e, Anteroposterior view. Roentgenogram taken at 8 months. f, Lateral view.

not constitute a pretty speculative gossip, but represents the effective application of the simplest laws of physics to a clinical problem.

The advantages of double pulley traction are:

1. It is a comfortable, easily adjustable form of axis traction which can be used in definitive fashion for the treatment of fractures of the distal half of the shaft of the humerus.

2. The entire arm is exposed thus facilitating the care of any soft tissue wounds, the taking of roentgenograms, and the application of physiotherapy to the injured area.

3. This apparatus is equally applicable to children and adults since there is no trauma to bone (as is the case where pins and wires are used), no irritation of the skin, and no residual injury to the neighboring joints.

4. Its use does not interfere with the proper care of shock, nor does it hinder the simultaneous treatment of other injuries.

Its disadvantages are:

1. As a method of permanent extension, it requires the constant supervision of the house and nursing staffs.

2. As a peculiarly effective form of traction, it is prone to cause overpull unless it is carefully watched.

3. The average period of hospitalization is 6 weeks. (This is not to be confused with the period of disability which is probably shortened.)

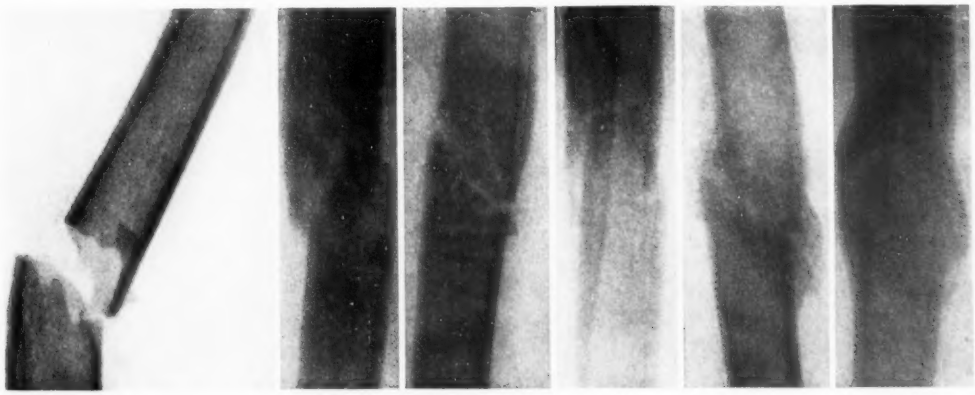

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Fig. 5. Case 3. a, Anteroposterior view. X-ray films taken on admission. b, Lateral view. c, Anteroposterior view. Angles have been adjusted. Roentgenogram taken at 3 days. d, Lateral view. e, Anteroposterior view. Roentgenogram taken at 3 months. f, Lateral view.

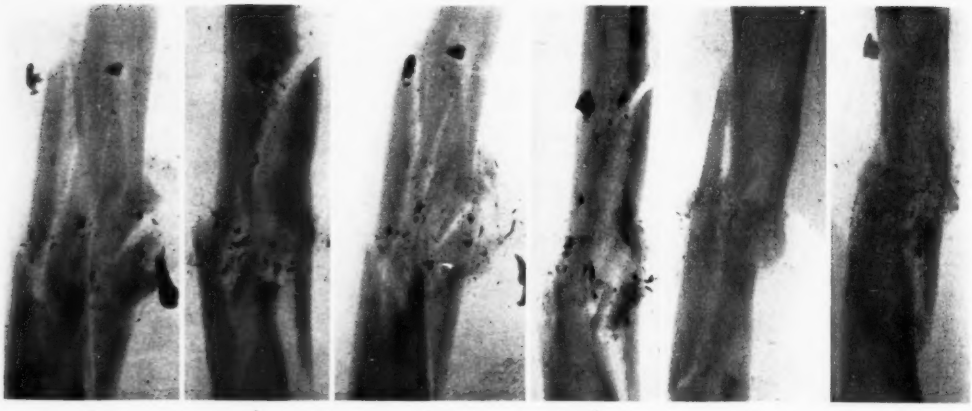

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Fig. 6. Case 4. a, Anteroposterior view. Gunshot wound. X-ray film taken at 15 hours. b, Lateral view. c, Anteroposterior view. Wounds healed. X-ray film taken at 4 weeks. d, Lateral view. e, Anteroposterior view. Roentgenogram which was taken at 4 months. f, Lateral view.

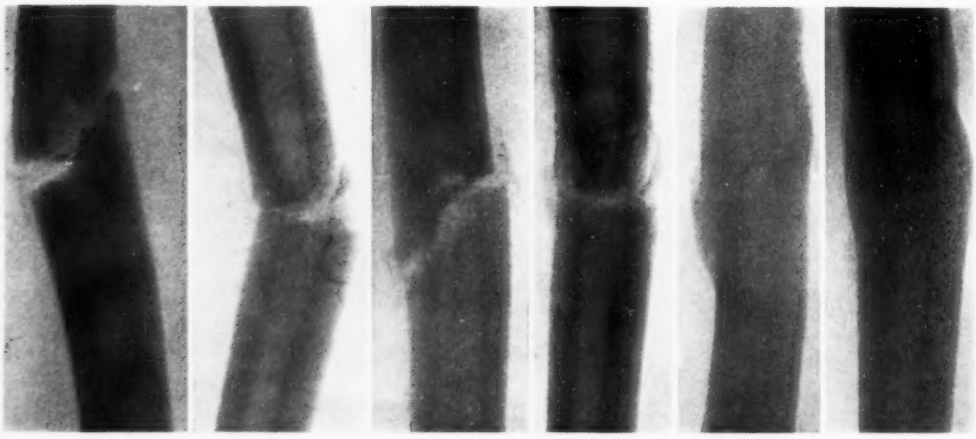
The indications for its use have been arrived at, and properly so, on an empirical basis. This will be evident in the following case reports.

In our experience, double pulley traction has proved a method of choice in the treatment of fractures of the shaft of the humerus below the deltoid tubercle and of compounded fractures in any part of the shaft.

CASE REPORTS

The following cases have been treated by members of the surgical staff of the Beekman Street Hospital, each surgeon using the apparatus where and when he thought it indicated.

CASE 1. (Fig. 3). F.S., a robust 57 year old white male, was admitted to the hospital on April 20, 1936, shortly after being struck by a cab. He suffered a transverse fracture in the middle third of his right humerus. Admission x-ray films revealed marked angulation with overriding despite strong emergency traction. After 6 hours in 5 pound double pulley traction, there was still ½ inch overriding. At 24 hours full length had been obtained, but there was a 20 degree angulation on the lateral view. At 48 hours, this had been corrected by appropriate adjustment of the angles of the apparatus. On the eleventh day,



a b c d e f

Fig. 7. Case 5. a, Anteroposterior view. X-ray film taken at 27 days. Weight reduced. Angulation. b, Lateral view. c, Anteroposterior view. X-ray film taken 2 weeks later. Angles adjusted. Weight changed. d, Lateral view, e, Anteroposterior view. X-ray film taken at 6 months. f, Lateral view.

the weight was reduced to 4 pounds, but despite this, overpull became apparent on the fifteenth day. Callus was visible on the twenty-fifth day and by the thirty-second day, the fragments had been re-approximated but with some angulation. There was a complication of phlebitis in the right leg with subsequent pulmonary embolization which prolonged the hospital stay until July 11, 1936. Because of the overpull, clinical union was delayed until June 25, 1937.

This case exemplifies the efficient function of the apparatus in correcting angulation. Despite care in trying to avoid its occurrence, overpull did take place, with its usual sequelæ of delayed union and prolonged hospitalization.

CASE 2 (Fig. 4). C.F., a 30 year old white male, was admitted to the hospital on October 15, 1934, shortly after a fall on his left arm. He had a T fracture which began near the middle of the shaft of the humerus and extended into the elbow joint thus separating the capitellum and trochlea. X-ray films showed a 25 degree anterior angulation after a few hours in 5 pound double pulley traction. The angles were adjusted and, at 48 hours, the alinement was improved to one of 5 degrees of deviation. A cock-up splint was applied to the wrist because of symptoms of radial nerve contusion. The position was maintained for 37 days, at which time the callus was satisfactory and union sufficiently firm to discard the traction. He was discharged on November 25, 1934. Follow-up examination at 2 years showed an A4, E4, F4 result.

This type of fracture is a most difficult one to handle. The excellent anatomical and functional result is a tribute to the efficacy of this apparatus. In particular, the attainment of complete, painless elbow joint function is worthy of note.

CASE 3 (Fig. 5). J.R., a 66 year old white male, was admitted to the hospital on October 5, 1934, several hours after falling down a flight of stairs. Roentgenograms showed an oblique fracture in the middle third of the right humerus with definite angulation. After 36 hours of 5 pound double pulley traction, some angulation persisted. Accordingly, the pulleys were adjusted and the weight increased to 7 pounds. Twenty-four hours later, anatomical alinement was attained and the original 5 pound traction restored because of slight overpull. An excellent position was maintained for 53 days in traction because of delay in union (overpull). Some callus had been evident at the twenty-fourth day. The patient was discharged on December 1, 1934. Follow-up examination at 5 months revealed complete function of the shoulder except in the extremes of rotation, and all other joints were normal. An A4, E4, F3 (unemployed) result had been obtained.

CASE 4 (Fig. 6). J.C., a 39 year old white male, was admitted to the hospital on March 21, 1934, 20 minutes after his left upper arm had been shattered by a charge of buckshot. There was an extensive, compounded, comminuted fracture of the upper third of the left humerus. Following cleansing of the wounds, the extremity was placed in 4 pound double pulley traction. The fragments were maintained in this fashion while the arm was left free for dressings throughout the period of hospitalization. Callus was evident at 26 days and the wounds were healed 1 week later. The patient was out of traction on the forty-third day. Follow-up examination at 10 months revealed an A4, E4, F4 result.

CASE 5 (Fig. 7). V.S., a 46 year old white male, was admitted to the hospital on May 1, 1935, shortly after falling from a ladder. He suffered a short oblique fracture in the middle third of his right humerus. For the first 16 hours, 7 pound double pulley traction was applied. At the end of that period, there was a suggestion of overpull and the weight was reduced to 5 pounds, and the abduction increased from 45 to 75 degrees. By the twentieth day, the weight was reduced to 3 pounds in an effort to correct the overpull, but this resulted, despite increasing callus, in an angulation of 25 degrees by the twenty-sixth day. Correction was obtained by restoring the weight to 6 pounds without disturbing the angles. Firm union in the anatomical position was present by the forty-fourth day. He was discharged on June 21, 1935. Follow-up examination at 11 months showed an A4, E4, F3 result, with the elbow joint deficient in the last few degrees of extension.

This case demonstrates that overpull is prone to occur when more than 5 pound traction is used. Once overpull is present, very little can be gained by reducing the weight or by tinkering with the angles. The end-result was more than satisfactory.

CASE 6. E.K., a 48 year old white female, was admitted to the hospital on March 5, 1935, shortly after she fell downstairs, striking her left shoulder. She sustained a comminuted, impacted fracture of the surgical and anatomical necks of the left humerus. The extremity was placed in 5 pound double pulley traction, at 45 degrees' abduction. On the second day, an unsuccessful manipulation did not affect the angulation. The traction was continued until the eleventh day when 3 pounds was used. The fracture was slowly corrected until by the end of the fourth week anatomical reduction had been obtained. Traction was removed at 52 days and the patient was discharged on May 4, 1935. Follow-up examination at 7 months showed abduction to 135 degrees, complete rotation but evidence of traumatic neurosis.

This case merely demonstrates that double pulley traction can be used as a method of obtaining sufficiently strong pull to disimpact and realine the fragments of a fractured humeral head. This is not a true axis traction function.

CASE 7. J.H., a 57 year old white male, was admitted to the hospital on March 19, 1935, with a history of feeling something snap in his left arm while driving an automobile. He showed a fracture in the upper half of the shaft, which was treated for the first 6 days with 5 pound double pulley traction. At this time, the position was improved by adjusting the angles and increasing the weight to 7 pounds for a period of 5 days. After 4 weeks, the continued bone absorption and absence of callus led to a suspicion of pathological fracture. A roentgenogram of the chest revealed a tumor of the left upper lobe. At 50 days, the patient was removed from traction, a spica was applied, and he was transferred to a chronic hospital.

CASE 8. N.R., a 40 year old white male, was admitted to the hospital on February 28, 1936, shortly after being struck by an automobile. There were comminuted fractures of the body and neck of the left scapula. It was a collapsing type of injury so that the glenoid fossa with the head of the humerus lay in the anterior axilla. The left upper extremity was placed in full abduction in 7

pound Blake board traction suspension. At 3 days, there was some improvement, but the skin of the arm began to blister. At 10 days, 5 pound double pulley traction was instituted for two reasons. First, the brachial skin was breaking down and second, a more effective pull was indicated. Thereafter, there was some further improvement, and on the twentieth day, the extremity was removed from traction with excellent motion of the shoulder.

This case demonstrates the advantageous use of double pulley traction without regard to its axis traction qualities. An effective comfortable pull of 11 pounds replaced the skin damaging 7 pound (effective 4 pound) pull of Blake board extension.

CASE 9. R.P., a 12 year old white female, was admitted to the hospital on May 31, 1935, a few minutes after falling over a box and sustaining an irregularly transverse fracture in the lower third of the shaft of her left humerus. After 18 hours in 4 pound double pulley traction, there was still some overriding with transposition of the fragments. The fracture site was manipulated under general anesthesia and the extremity then returned to 5 pound traction. At 4 days, an anatomical position had been obtained, but, because of slight overpull, the weight was reduced to 3 pounds. Twenty-four hours later, x-ray examination showed a 10 degree anterior angulation due to the weight reduction. With the aid of the protractor, the angles were altered so that accurate reduction was restored within 48 hours. At 25 days, there was good callus and clinical union. Traction was removed at 28 days and coaptation splints were applied. The patient was discharged on June 29, 1935. Follow-up examination at 10 months revealed an A4, E4, F4 result.

CASE 10. N.A., a 13 year old negro, was admitted to the hospital on May 7, 1933, shortly after suffering an oblique fracture in the distal third of the shaft of his right humerus. The extremity was placed in 3 pound double pulley traction. After 9 hours, ½ pound was added. X-ray examination at 20 hours showed good alinement with a 5 degree anterior angulation. At 3 days, an extra sling was introduced which caused an anterior angulation of 22 degrees within 24 hours. The sling was removed and by adjusting the pulleys, this was corrected to one of 10 degrees. At 17 days, callus was evident, and by the thirty-seventh day, union was sufficiently firm to remove the traction. At 40 days, union was solid, and the patient was discharged.

This was our first case. The trouble with the extra sling proved a fortunate event since it demonstrated that angulation could be promptly corrected by proper adjustment of the angles.

CASE 11. J.G., a 14 year old white male, was admitted to the hospital on August 6, 1933, shortly after his right arm had been caught between two trucks, resulting in a transverse fracture in the middle third of the humerus. The extremity was placed in 3 pound double pulley traction. Roentgenograms at 9 hours revealed a 20 degree anterior angulation. The pulleys were then adjusted to elevate the direction of the resultant. At 2 days, the fragments were in anatomical position. The weight was reduced to 2 pounds to avoid overpull. At 4 weeks, there was a fair amount of callus present. At 7 weeks, union was solid, and the patient was discharged. Follow-up examination at 14 months revealed an A4, E4, F4 result.

This patient was maintained in traction for so long a period because of his lack of co-operation.

CASE 12. L.C., a 65 year old white female, was admitted to the hospital on June 21, 1936, with a fresh oblique fracture in the upper third of the right humerus. The extremity was placed in 2 pound double pulley traction. There was some angulation which was still present at the eleventh day, when, because of the danger of hypostatic pneumonia, 5 pound Blake board traction was substituted. In this way, the patient could be propped up. On the twenty-fifth day, a plaster spica was applied, and the patient was discharged on July 15, 1936.

This case was one for an ambulatory method of treatment from the start. Unless the criteria for the proper use of double pulley traction can be satisfied, its use is contra-indicated.

CASE 13. B.R., a 48 year old white male, was admitted to the hospital on March 29, 1936, 20 minutes after falling from a ladder. He sustained a skull fracture with brain injury in addition to a comminuted fracture of the surgical neck of the left humerus. The extremity was put up in 6 pound Blake board extension. After 1 week, the skin on the arm began to break down. Since bed rest was still enforced by the cranial injury, it was felt that the arm might as well benefit by continued traction. Therefore, 2 pound double pulley traction was instituted. On the twenty-eighth day, callus was present and traction was discontinued. He was discharged on April 28, 1936. Follow-up examination at 5 months revealed some limitation in full abduction, in extension, and in the extremes of internal rotation. The elbow was normal.

CASE 14. J.F., a 43 year old white male, was admitted to the hospital on January 30, 1936, after being caught between two trucks. He suffered multiple injuries and shock, as well as a short oblique fracture through the middle third of the left humerus. Because of angulation and overriding 6 pound double pulley traction was applied. After several hours, overpull was evident on the roentgenogram, and the weight was reduced on successive days in an attempt to approximate the fragments. This was naturally unsuccessful, and, on the fifteenth day, the patient's condition was sufficiently good to allow of open operation. A Lane plate was inserted and convalescence was satisfactory. Callus appeared on the thirty-seventh day, and the patient was discharged on March 22, 1936.

This case can be summarized with the one word "overpull." Where the patient is enervated by shock or multiple soft tissue injuries, particular care must be taken not to apply too much weight.

CASE 15. H.F., a 60 year old white male, was admitted to the hospital on July 26, 1935, shortly after slipping on the street and sustaining a comminuted fracture through the upper third of the right humerus. The extremity was placed in 5 pound double pulley traction and an excellent position was obtained and maintained. On the twentieth day, callus was evident and the weight was reduced to 2 pounds. Traction was removed on the thirty-first day and the patient was discharged with the arm in coaptation splints on August 30, 1935.

CASE 16. R.P., a 65 year old white male, was admitted to the hospital on January 22, 1935, with a history of having fallen against a desk, several hours before. Roentgenograms revealed an impacted fracture of the surgical neck of the right humerus, also involving the greater

tuberosity. Double pulley traction of 6 pounds was applied because of the impaction. The extremity was gradually abducted with the fragments in good position. However, his general condition was not deemed satisfactory and a plaster spica was accordingly applied in order to get the patient out of bed. He was discharged in this on February 4, 1935.

In general, there would seem no indication for the use of this apparatus in fractures of the upper shaft and surgical neck, unless compounded. In this case, it was employed merely as an effective comfortable means of obtaining strong traction.

CASE 17. S.R., a 69 year old white male, was admitted to the hospital on November 10, 1936, shortly after being run over by a truck. He suffered multiple fractures including a compound, splintered fracture in the lower extremity of the right humerus. The patient was treated for shock, as well as for the local injuries. Blake board traction of 4 pounds was applied to the right arm. After 48 hours, it was evident that this was inadequate and 4 pound double pulley traction was used. Roentgenograms after 72 hours revealed definite improvement with good alinement and approximation of the condyles. The soft tissue wound was readily dressed and remained clean. At the end of 2 weeks, the patient expired because of bronchopneumonia and exhaustion.

This case again serves to demonstrate that double pulley traction is most effective in the distal half of the humerus.

CASE 18. F.T., an 18 year old white female, was admitted to the hospital on January 10, 1935, with an irregularly transverse fracture through the surgical neck of the left humerus. Because of the marked impaction with some malalinement, 5 pound double pulley traction, in 30 degrees of abduction, was applied. After 24 hours, angulation with rotation was evident and a manipulation under anesthesia was necessary. On the fifth day, a second manipulation was performed, without success. Twenty-four hours later, a third manipulation was done with successful retention by extending the extremity directly overhead. It was retained in this fashion until the twenty-third day. The patient was discharged on February 6, 1935. Follow-up examination at 4 months revealed complete shoulder function.

Double pulley traction was used here because we had as yet not learned that it had nothing to offer in the treatment of simple fractures proximal to the deltoid tuberosity.

CASE 19. M.A., a 20 year old white female, was admitted to the hospital on October 1, 1936, after falling 4 stories to the street. She suffered 5 major fractures in addition to a compounded, comminuted, supracondylar fracture of the right humerus extending into the joint. The extremity was placed in 3 pound double pulley traction. The original position was one of overriding of the fragments with separation of the condyles and a 20 degree anterior angulation. Within 24 hours, this was corrected to one of good alinement, complete correction of the angulation, and approximation of the condyles. This position was maintained until the patient expired on the sixth day.

In this type of fracture, double pulley traction is the optimal method of treatment because plaster retention would be ineffective due to slipping, manipulation is impossible because of the hazardous condition of the patient, and finally the soft tissue wounds can be satisfactorily dressed.

CASE 20. F.R., a 28 year old white male, was admitted to the hospital on April 15, 1934, 1 hour after being thrown from a horse. The injuries were confined to the left upper extremity. They were a transverse fracture in the upper third of the humerus, fractures of both radial and ulnar styloid processes, fracture of the navicular, and dislocations of the os lunatum and os magnum. The carpal injuries were reduced by manipulation, and, simultaneously an unsuccessful attempt was made to reduce the humerus fracture, but the fragments could not be maintained in position. Accordingly, the arm was placed in 6 pound double pulley traction in adduction. On the fourth day, another manipulation was unsuccessful. At the end of the second week, when the skin was in good condition, an open operation with insertion of a Lane plate was performed. The patient was discharged on May 17, 1934. Follow-up examination at 18 months revealed an A4, E4, F4 result.

It is a clinical fact that any form of traction is ineffective in the reduction and maintenance of transverse fractures just below the surgical neck of the humerus.

CASE 21. T.W., a 44 year old white male, was admitted to the hospital on November 8, 1934, several hours after a fall in the street. He suffered an oblique fracture in the middle third of the right humerus. The extremity was placed in 6 pound double pulley traction in a 30 degree abduction. At the end of 48 hours, the position of the fragments was improved. At 5 days, a manipulation under general anesthesia was deemed necessary. At four weeks, the weight was reduced to 4½ pounds, and there was fair callus formation. Traction was removed on the thirty-third day; union was solid. The patient was discharged on December 17, 1934. Follow-up examination at 5 months revealed an A3, F3 (out of job) result.

CASE 22. M.R., a 38 year old white female, was admitted to the hospital on December 9, 1935, shortly after falling downstairs. She sustained an oblique fracture in the lower third of the shaft of the humerus. The arm was placed in 6 pound Blake board traction. At 6 days, there was a persistent 20 degree anterior angulation. Double pulley traction of 4 pounds was then applied. Within 24 hours, the angulation was corrected and the alinement remained good until she was discharged from the hospital. Follow-up at 8 months revealed an A4, E4, F4 result.

CASE 23. C.S., a 55 year old white male, was admitted to the hospital on January 27, 1936, after a fall from an elevated platform. There was a comminuted oblique fracture of the upper third of the right humerus extending into the surgical neck, with considerable rotation of the fragments. Double pulley traction of 5 pounds was applied in full abduction. The following day, a manipulation under local anesthesia was performed and traction was resumed. The improved position was maintained with 3 pounds, after the fifth day. Callus was evident at 4 weeks and the patient was discharged on March 23, 1936, with a returning function of the shoulder.

CASE 24. J.Y., a 21 year old white female, was admitted to the hospital on August 28, 1934, shortly after a fall. She sustained a fracture of the surgical neck of the left

humerus. The extremity was placed in 3 pound double pulley traction, the arm being gradually abducted to 90 degrees within 24 hours. At this time, x-ray examination showed a medial angulation of 30 degrees, obviously due to the abduction. The weight was increased to 5 pounds on the eleventh day; a manipulation under general anesthesia was performed with no success. Callus was evident at 29 days, and traction was removed at end of sixth week. Follow-up at 10 months revealed an A3, E4, F4 result.

Double pulley traction has nothing to offer in the care of a fracture of the surgical neck, unless there is a soft tissue wound and extension is otherwise indicated.

CONCLUSION

The indications, advantages, and limitations of double pulley traction are presented on the basis of its use in the treatment of 24 cases of fracture of the humerus. It has proven itself to be a definitive, axis traction apparatus which gives excellent results when properly employed.

UTERINE CURETTAGE AS AN AID IN THE DIAGNOSIS OF ECTOPIC PREGNANCY

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ALTHOUGH extensive investigation has been devoted to the diagnosis of ectopic pregnancy, the variable clinical aspects of the condition still offer many difficulties in its recognition. Indeed, different studies give the incidence of incorrect diagnoses as ranging from 15 to 40 per cent. In doubtful cases with obscure symptoms and signs, provided there is sufficient time, properly interpreted pregnancy tests can sometimes be of assistance. A recent report by Hope indicates that peritoneoscopy (laparoscopy) may become a valuable aid. One would think that this procedure, if it proves to be not too difficult or dangerous, should at least displace aspiration by needle of the posterior cul-de-sac for the discovery of free blood in the pelvis.

In 1936, one of us published an article (7) on the association of decidual reaction of the endometrium with extra-uterine pregnancy in which it was concluded that in the case of at least some patients the findings at uterine curettage could be of considerable value in differential diagnosis. The material for this investigation consisted of the patients with extra-uterine pregnancy who were operated upon at Harper Hospital during the 5 year period ending March 31, 1935. An examination of patients with similar conditions occurring in the next 2 years was found to confirm the first in all essentials. For the present study, then, the two groups are combined, thus giving a more substantial series for statistical purposes.

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In the previous article a review of the literature showed a remarkable disagreement among authors of textbooks as to the diagnostic usefulness and reliability of curettage in ectopic pregnancy. Some stressed it as important, others as unreliable. Still others thought curettage too dangerous in extra-uterine pregnancy for use in diagnosis. Many made little or no mention of the procedure, and the same can be said for authors of articles in the periodical literature. A recent exception is Mathieu, who found curettage of great diagnostic assistance in 2 cases.

Considering the dangers first, a rather careful review of the literature for the last 10 years yielded no convincing data to support the opinion noted above. Moreover, in the records of our cases there was nothing to indicate that curettage had been harmful. Indeed, it does not seem that a properly performed curettage should be as likely a cause of rupture of the pregnant tube as the usual bimanual pelvic examination.

If it is true, then, that curettage is not unduly dangerous, the importance of the matter is to be found in the degree of reliability or usefulness of the procedure. Again referring to the previous paper, it may be considered as established that in any pregnancy, uterine or extra-uterine, the endometrium undergoes characteristic decidual changes. With uterine pregnancy there will be fetal or chorionic tissue (chorionic villi) in addition to decidua. The presence or not of chorionic villi has long been considered as possibly significant in differential diagnosis. Later observations have shown that, though there may be a

slight chance of error, the presence in the uterus of decidua alone is at least strong presumptive evidence of extra-uterine pregnancy. On the other hand, the absence of decidual changes in the endometrium cannot be taken as dependable evidence against ectopic pregnancy, since the decidua is usually cast off subsequent to death of the ovum. The latter, though no longer developing, may still be a cause of internal bleeding. However, even in such event, the absence of villi in the findings at curettage, and regardless of the type of endometrium, could be of distinct value at times in ruling out uterine abortion as a cause of the symptoms.

In view of the foregoing evidence that curettage is not unduly dangerous in ectopic pregnancy and that it can possibly be of considerable diagnostic assistance in obscure cases, we have studied the 38 Harper Hospital cases of definite extra-uterine pregnancy with available specimens of endometrium. These were found among the 171 patients who were treated by operation during the 7 year period ending March 31, 1937. In each instance the diagnosis was proved by the extra-uterine presence of a fetus or chorionic villi. The specimens of endometrium for the 38 cases were obtained by uterine curettage in 29, by hysterectomy in 6, and by decidual cast or discharged fragments in 3.

By accepting for study none but proved cases of ectopic pregnancy, we have attempted to avoid possible errors in some of the other reports. Furthermore, the specimens of endometrium from our cases were diagnosed in the laboratory before the full hospital records were consulted in regard to the duration of bleeding and other clinical features. Nor, do we question the reliability of the majority of the histories as the women were, with two exceptions, private patients and therefore probably for the most part sufficiently intelligent and informed to give a good account of their symptoms. We have indicated indefinite or questionable data in Table I by plus and minus signs or question marks. It is unfortunate from the standpoint of accuracy that we have been able to trace, for comparison, only a few instances of suspected extra-uterine pregnancy with curettage, but in which some other condition was found at operation. Some of these were incomplete abortions with decidua and chorionic villi in the curettings; in no case was there intact decidua alone.

In Table I the 38 Harper Hospital cases are arranged according to days elapsing between the onset of abnormal bleeding and the time when the endometrium was obtained. There is also shown the number of days since the last normal men-

TABLE I.—HARPER HOSPITAL CASES OF EXTRA-UTERINE PREGNANCY—SHOWING DURATION OF VAGINAL BLEEDING AND TYPE OF ENDOMETRIUM

Harper Hospital case number	Specimen obtained by	Last menstrual period—Days before specimen obtained	Onset of hemorrhage—Days before specimen obtained	Endometrium Type or phase
1 73918	Curettage	49	1	Intact decidua
2 84937	Curettage	50	4	Intact decidua
3 96097	Curettage	54	4	Intact decidua
4 57104	Pieces expelled	66	5	Intact decidua
5 59430	Curettage	48	5	Intact decidua
6 132863	Curettage	56	7	Intact decidua
7 143117	Curettage	35	7	Intact decidua
8 144637	Decidual cast	46	8	Intact decidua
9 131450	Curettage	42	9	Intact decidua
10 114405	Curettage	67	10	Intact decidua
11 112973	Decidual cast	64	11	Intact decidua
12 117729	Curettage	48	11	Proliferative
13 93097	Curettage	45	13	Intact decidua
14 90394	Curettage	52	14	Intact decidua
15 103507	Curettage	20?	14	Proliferative
16 129130	Hysterectomy	42	15	Intact decidua
17 87922	Curettage	?	18	Intact decidua
18 103241	Curettage	77?	18	Proliferative
19 63808	Hysterectomy	65	23	Intact decidua
20 129918	Curettage	72	23	Proliferative
21 43171	Curettage	25?	25	Early decidua
22 113463	Curettage	62	27	Proliferative
23 144919	Curettage	48	28	Intact decidua
24 138922	Curettage	70	28	Proliferative
25 117457	Hysterectomy	62	28	Proliferative
26 143043	Hysterectomy	63	28	Proliferative
27 111788	Curettage	51	30	Early secretory
28 57022	Curettage	90 + or −	30	Early secretory
29 88276	Curettage	76	32	Decidual glands
30 41519	Hysterectomy	75	34	Intact decidua
31 113045	Curettage	79	34	Proliferative
32 80620	Curettage	56?	50	Intact decidua
33 127340	Hysterectomy	?	50	Proliferative
34 47228	Curettage	117?	63?	Middle secretory
35 97039	Curettage	94 + or −	65 + or −	Intact decidua
36 125414	Curettage	140	70	Proliferative
37 131261	Curettage	109	72	Proliferative
38 113305	Curettage	140 + or −	85 + or −	Proliferative

TABLE II.—FIVE SERIES OF EXTRA-UTERINE PREGNANCIES SHOWING INCIDENCE OF DECIDUA ACCORDING TO ONSET OF ABNORMAL BLEEDING BEFORE ENDOMETRIUM WAS OBTAINED

Onset of abnormal bleeding before specimen secured	Series	Cases	Decidua	Percentage
None to 1 week	Sampson	2	2	100.0
	Geist and Matus	11	10	90.9
	Moritz and Douglas	12	2	16.7
	Boerner	11	10	90.9
	Harper Hospital	7	7	100.0
	Total	43	31	72.1
8 days to 2 weeks	Sampson	3	1	33.3
	Geist and Matus	12	7	58.3
	Moritz and Douglas	11	2	18.2
	Boerner	4	1	25.0
	Harper Hospital	8	6	75.0
	Total	38	17	47.4
15 days to 3 weeks	Sampson	1	0	0.0
	Geist and Matus	6	2	33.3
	Moritz and Douglas	6	1	16.7
	Boerner	7	2	28.6
	Harper Hospital	3	2	66.7
	Total	23	7	30.4
22 days to 4 weeks	Sampson	8	2	25.0
	Geist and Matus	4	2	50.0
	Moritz and Douglas	12	1	8.3
	Boerner	4	1	25.0
	Harper Hospital	8	3	37.5
	Total	36	9	25.0
29 days to 12 weeks	Sampson	11	0	0.0
	Geist and Matus	6	2	33.3
	Moritz and Douglas	12	2	16.7
	Boerner	4	0	0.0
	Harper Hospital	12	4	33.3
	Total	45	8	17.8
	All cases	185	72	38.9

strual period, the method by which the endometrium was secured, and the endometrium type or phase. It is seen that where abnormal bleeding had lasted 10 days or less, intact decidua was found in every instance. After this time there was an increasing incidence of the cyclic phases of the endometrium, and in one instance (Case 29) partially desquamated decidua was found. However, it is noteworthy that intact decidua was present several times following prolonged bleeding—with, of course, the same diagnostic significance. As stated before, even when intact decidua is not present, the absence of chorionic villi in the curettings could be taken as evidence against uterine abortion. Although this series contains too few cases for definite statistical conclusions, the results are sufficiently striking to indicate that those who have opposed diagnostic curettage in extra-uterine pregnancy have greatly underrated the value of the procedure.

In the literature there are at least four other series of ectopic pregnancies which give sufficient data to permit a comparison with ours. In order of publication these are tabulated in Table II along with ours so as to show the occurrence of decidua in relation to the duration of abnormal bleeding. It is evident that 3 of these series (those of Sampson, of Geist and Matus, and of Boerner) show a general agreement with ours, the differences being explained possibly by the small numbers involved or by different criteria in the selection of cases for study. Moritz and Douglas reported the only series showing little or no relationship between the occurrence of decidua and the duration of bleeding. However, even with the inclusion of their exceptional findings, averages calculated from all 5 series (which together form a group of substantial size) indicate a high incidence of decidua with recent onset of abnormal bleeding. Furthermore, it is seen that although the incidence of decidua decreases with increased duration of bleeding, this significant finding may be expected in some cases even after prolonged bleeding.

The impression regarding the value of curettage which is obtained from the foregoing data is substantiated by the clinical records of the 29 patients in our series who were subjected to diagnostic curettage. The histories of these 29 patients show that the duration of abnormal bleeding varied from 1 to 85 days (Table I). The majority presented obscure symptoms and signs, yet in 15 there was intact decidua without chorionic villi—a finding presenting a high degree of diagnostic probability and usefulness. The following case was of this group:

CASE 1. J. B., aged 34 years. Married 10 years with 1 full term pregnancy 5 years before the present illness; no miscarriages. The pregnancy occurred after 4 years of sterility for which treatment had been given. The last menstrual period was on March 26, 1936. Beginning on April 22 and lasting for 3 days there had been lower abdominal cramps such as usually occurred with menstruation. Several days later there was a dull pain which gradually became "like a toothache" and was more marked in the lower left quadrant. On May 15, two nights before admission, slight vaginal bleeding began.

Patient was admitted to the hospital on May 17, 1936. Blood pressure was 108/68; temperature, 99 degrees; pulse, 80; hemoglobin, 81 per cent; white blood count, 10,100. Abdominal palpation showed diffuse tenderness below the umbilicus, and vaginal examination gave indefinite findings except for tenderness in the region of the left adnexa. On May 19, the Friedman reaction was positive for pregnancy. Two days later curettage yielded a large amount of material, and the operator believed he was dealing with an incomplete abortion. However, microscopic examination of the curettings showed typical decidual reaction of the endometrium but no chorionic villi. At abdominal operation on May 23 "a very small amount of free blood" was found in the pelvic cavity, and also an

unruptured left tubal pregnancy measuring 1 by 1¾ inches in which was later found a fetus. The left tube was removed. Convalescence was uneventful, and the patient was discharged from the hospital on June 6, 1936.

The following case is illustrative of the group in which decidua was not present but in which the findings were, nevertheless, of some importance.

CASE 2. W. B., aged 33 years. Married for a number of years but never pregnant. The last regular menstrual period began on December 18, 1935. On February 21, the patient experienced a sudden lower abdominal pain. The pain continued and on the following day was so severe that she fainted. Vaginal bleeding began at this time and was continuous for a week. "Spotting" followed, and at one time clots and a sort of "skin" were passed. This tissue was not examined microscopically. Shortly after the onset of pain the Friedman test for pregnancy was positive. Moderate abdominal pain continued intermittently.

Because of persistence of the symptoms, the patient was admitted to the hospital on March 15, 1936. The blood pressure was 128/80; pulse, 90; hemoglobin, 77 per cent; and white blood count, 7,900. History and examination at this time suggested tubal abortion (left) or incomplete uterine abortion. On March 16, examination under anesthesia revealed a mass 3 by 3 centimeters in size apparently attached to the left cornua of the uterus. Uterine curettage at the same time yielded a moderate amount of tissue which on microscopic examination was found to be endometrium in the proliferative phase. There were no chorionic villi. At abdominal operation on March 18, a "small amount of free blood was found in the abdominal cavity." The omentum was adherent to the bladder and over the uterus, adnexa, and sigmoid. After separation of the adhesions, the gangrenous left tube and the ovary were seen to be involved in old blood clot and adhesions. The left tube and ovary were removed with difficulty. Except for several days, on which the patient was febrile, the course following operation was satisfactory, and the patient went home on March 28, 1936.

SUMMARY

In view of the frequent difficulties met with in the recognition of ectopic pregnancy, a study was made of uterine curettage as a diagnostic aid. The procedure is apparently not unduly dangerous, and the finding of intact decidua without chorionic villi is strong presumptive evidence of extra-uterine pregnancy. In 38 cases of proved ectopic pregnancy with available specimens of endometrium, intact decidua alone was present in all cases with abnormal bleeding of 10 days or less and in a considerable proportion of those with more prolonged bleeding. The absence of decidual reaction is not reliable evidence against ectopic pregnancy. However, if chorionic villi are also absent, the findings may be of value in ruling out uterine abortion as a cause of the bleeding. Three of 4 somewhat comparable series found in the literature confirmed our results in large part. Two illustrative case reports are given.

Note.—We wish to take this opportunity to thank Dr. P. F. Morse for permission to use the pathological material from the Laboratory of Harper Hospital.

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POSTERIOR GASTROJEJUNOSTOMY

An Unusual Error in Technique

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TEXTBOOKS of surgery and special monographs dealing with the technique of retrocolic gastrojejunostomy not infrequently fail to give definite instructions for the proper placing of the anastomosis with relation to the middle colic artery. For example, Fowler in 1906 stated, "A slit is made in the transverse mesocolon at the point where it is in relation to the posterior wall of the stomach." Moynihan in 1908 wrote, "The jejunal direction being carefully noted, the transverse mesocolon is divided at a spot devoid of blood vessels close to the duodenojejunal flexure." Mayo-Robson in 1910 said, "A vertical slit is then made in the transverse mesocolon between the blood vessels which are readily seen." Moynihan in 1904 again wrote, "At a bloodless spot in the arch of the middle colic artery a clip is applied to the under surface of the mesocolon." In 1920 Warbasse described the procedure as follows, "A small vertical incision is made in the mesocolon at this point between the blood vessels." The point referred to is the under surface of the mesocolon which is made to bulge when the stomach is pressed forward against it. Bickham, in his *Operative Surgery*, 1934, is more accurate; he writes, "The mesocolon is caught with forceps and drawn away from the posterior stomach wall while its structure is divided by knife or scissors through a non-vascular area just to the left of the duodenojejunal junction." Horsley, 1928, gave this description, "The stomach and transverse colon are lifted out of the wound making taut the transverse mesocolon which is divided for 7 centimeters between vessels exposing the posterior wall of the stomach." Romanis and Mitchiner, 1929, say, "A large opening is made in the mesocolon at a bloodless spot and the posterior wall of the stomach is pushed through this." In Nelson's *Surgery*, Walton states, "The mesocolic artery should be identified and the bloodless area to the left of it freely incised," and Horsley in Lewis' *Practice of Surgery* says, "An incision is made in the mesocolon about the midline or slightly to the left, avoiding the large blood vessels." Babcock's *Textbook of Surgery*, 1935, evidently quotes from Horsley, "The stomach and transverse colon are lifted out of the wound making taut the transverse mesocolon which is divided for 7 centimeters between the vessels exposing the posterior wall of the stomach." Probably the most complete description appears in a recent monograph by Eusterman and Balfour, 1936, "The transverse colon is then elevated and the mesocolon inspected for the most suitable area through which the segment of the stomach selected for the anastomosis is to be drawn and in this selection there is usually no difficulty. Occasionally, however, there may be a choice in the arcades of the mesocolon as they have been formed by vessels of the branches of the mesocolic vessels; if there is, the arcade farthest to the left side of the patient should be chosen."

No special emphasis apparently seems to have been given to a discussion of possible dire results, if this point be disregarded and the anastomosis be made through the mesocolon to the right of the middle colic artery. A review of the literature since 1901 fails to reveal any mention of instances of malfunction due to occlusion of the jejunal limbs by the vascular pedicle as a result of failure to place the anastomosis to the left of the middle colic vessels. It will be remembered that the middle colic artery is a branch of the superior mesenteric artery which latter springs from the front of the aorta just above the level of the root of the transverse mesocolon (Fig. 1). This middle colic artery is a vessel of quite some importance inasmuch as it carries the blood supply to the middle portion of the colon and, if it is injured, it is probable that the consequence will be serious. It is accompanied by the middle colic vein which brings the blood back from the same portion of the colon, pouring it into the superior mesenteric vein, which latter, joining the splenic, forms the portal vein. These two vessels, then—the middle colic artery and vein—form in the mesocolon a strand of some thickness, the artery at its beginning being about as thick as the brachial, and the vein is correspondingly large. One can now understand that when the individual stands or sits the transverse colon sags and the middle colic

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artery is brought closer to the superior mesenteric artery from which it springs. Of course, when seen during the performance of this operation, a wide interval separates these two arteries, perhaps more than a right angle, depending on the distance to which the colon has been drawn up. Now the duodenum, as it goes on to become the jejunum, passes behind the superior mesenteric artery. If one remembers this he can easily visualize what happens when the first 3 inches of jejunum are picked up and drawn to the right of the median line (Fig. 2). The loop, both limbs of it, must come to lie in front of the superior mesenteric artery. If now, while it is thus drawn over to the right of the midline one were to return the colon to its natural position, the loop—both limbs of it—would be constricted between the middle colic vessels and the superior mesenteric vessels, as though between the blades of a clamp or scissors (Fig. 2a). But, furthermore, if now the summit of the loop is made to pass through the mesocolon to the right of the midcolic vessels and is then fastened to the stomach to the *left* of the midline, the constricting action of these vessels is intensified. And now, the summit of the curve is, we think, practically always anastomosed to the stomach to the left of the midline (as it should be whenever possible). Thus our loop will have made a half circle around the vessels—the middle colic artery and vein—and the more the stomach falls away to the left—as in the act of filling—just so much the more must the midcolic vessels constrict both limbs of the loop, and also just so much the more must the vessels be constricted by the loop. If the stomach is sewed firmly to the edge of the opening in the mesocolon and adheres firmly to it, the condition will be bad enough, but surgeons of experience know these two do not always adhere strongly and that, in fact, it is common enough to find a goodly loop going through and up to the stomach—even when a "no loop" operation has been done; and if such should occur after the opening in the mesocolon is made to the right of the middle colic vessels the results are more likely to be poor.

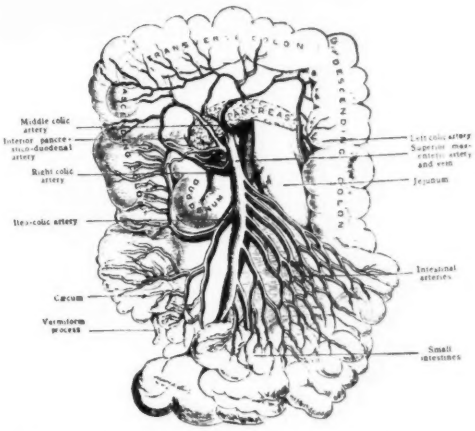


Fig. 1. This illustration shows how the middle colic artery and vein and the superior mesenteric vessels are widely separated when the transverse colon is drawn up and indicates the manner in which a loop of jejunum could be compressed as between the arms of a pair of pincers on replacement of the colon were the gastrojejunal anastomosis made to the right (patient's) of the middle colic vessels. (After Jackson.)

The following is a report of a patient studied by us in whom pain and regurgitant vomiting occurred as a result of obstruction to the proximal

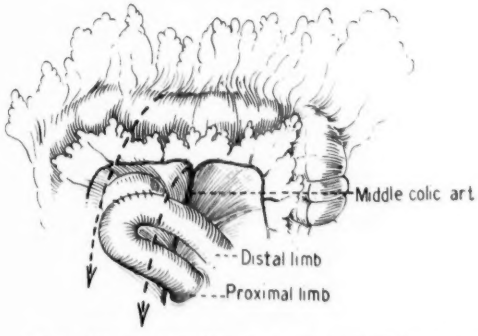


Fig. 2. One can visualize what happens when the first 3 inches of jejunum are picked up and drawn to the right of the midline.

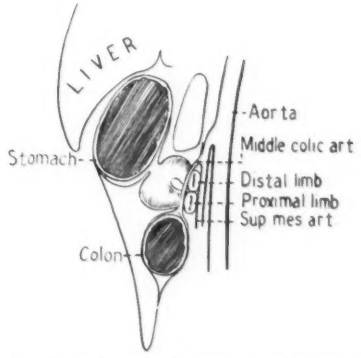


Fig. 2a. When the colon is returned to its normal position, both limbs of the loop are caught between the middle colic vessels and the superior mesenteric vessels as between the blades of a clamp or scissors.

Fig. 3. Pre-operative gastric roentgenogram. Note the dilatation of the duodenum and the gastro-enterostomy stoma. Barium was seen to leave by the distal limb but did not enter the proximal limb. Old entero-enterostomy not functioning; reverse peristalsis active in duodenum.

Fig. 3a. Postoperative gastric roentgenogram. The duodenum was now able to empty satisfactorily through the enlarged entero-enterostomy. The gastro-enterostomy is functioning fairly well as before.

and distal limbs of the loop of the jejunum due to failure to observe this principle.

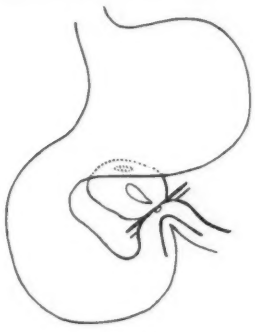
H.C., male, white, 32 years of age, was admitted to the Firmin Desloge Hospital, on January 22, 1936, complaining of pain in the epigastrium and of indigestion. Nine years previously, on October 27, 1927, in another institution, this patient had a posterior gastro-enterostomy and an appendectomy performed for duodenal ulcer. Shortly after operation he developed regurgitant vomiting which on November 7, 1927, required a second operation for relief. An operative note made at that time stated that the omentum and transverse colon were firmly adherent to the line of incision on the right side and that the proximal loop of the jejunum was considerably distended and kinked at an acute angle by adhesions to the stomach. There was also an apparent obstruction at the gastro-enterostomy stoma. This was relieved by an entero-enterostomy made between the proximal and distal loops of the jejunum. The incision was made to the left of the midline, as the first operative wound had become infected. The patient immediately was relieved of his acute obstructive symptoms but continued to have attacks of epigastric pain at intervals as before. Since 1933, following an injury to his back in an automobile accident, his gastro-intestinal symptoms have become progressively worse. The earlier attacks were relieved by food and bicarbonate of soda, but at present these are of no benefit and the pain is almost constant, with acute exacerbations at times of more severe pain radiating to the shoulder blades associated with vomiting. In the past month he has lost strength and at least 10 pounds in weight. Family and past histories are irrelevant to the present complaint.

On physical examination the patient appeared undernourished and in considerable distress because of pain in the upper abdomen. The head and neck were negative. Examination of the heart and lungs revealed nothing abnormal. The abdomen was scaphoid and there were 2 old operative scars in the upper abdomen—one on either side of the midline. The scar on the left was healed firmly while that on the right was the seat of a postincisional type of hernia situated at its middle third and measuring approximately ¾ inch in width and 1½ inches in length. There were no palpable masses and the liver and spleen could not be felt. There was a definite point of tenderness in the epigastrium to the left of the navel on deep palpation. There was tenderness also in the region of McBurney's point. The extremities were essentially negative. The systolic blood pressure was 95 millimeters of mercury and the diastolic 68 millimeters of mercury.

On laboratory examination the urinalysis was negative. There were 8,000 leucocytes, 5,270,000 erythrocytes, and 13.3 grams hemoglobin. The differential blood count was normal. The blood Wassermann and Kahn tests were negative. The blood non-protein nitrogen was 37 milligrams per 100 cubic centimeters and the blood sugar was 85 milligrams per 100 cubic centimeters. Gastric analysis showed free and combined acids within normal limits. The bleeding and clotting times were normal. Roentgenographic examination of the chest revealed an old bronchitis. X-ray examination of the stomach (Fig. 3) revealed a gastro-enterostomy stoma which was not functioning properly. The barium could be seen passing

Fig. 4.

Fig. 5.



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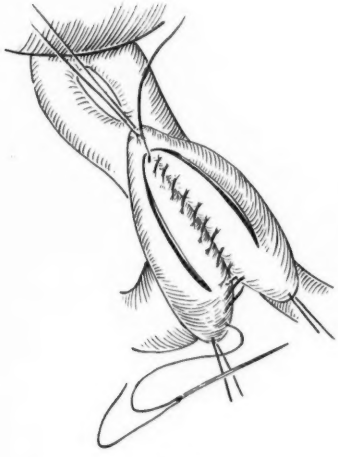

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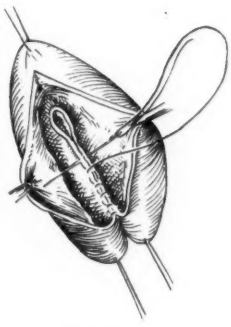

Fig. 8.

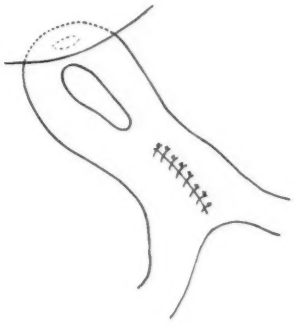

Fig. 9.

Fig. 4. Probable sequence of events in this patient at the time of the original operations. The anastomosis has been made to the right of the middle colic vessels. The two jejunal limbs are compressed and obstruction developed rapidly.

Fig. 5. An entero-enterostomy between proximal and distal limbs is done with relief of obstructive symptoms.

Fig. 6. The entero-enterostomy gradually becomes constructed with recurrence of obstructive symptoms. The solid line indicates the site of the new corrective anastomosis.

Figs. 7, 8, and 9. Steps in the operative procedure. A Finney pyloroplasty type of anastomosis is made between the duodenum and the jejunum distal to the site of obstruction.

through the distal loop of bowel. It did not enter the proximal loop. There was a deformity of the first part of the duodenum with associated tenderness and fixation due to adhesions. The barium passed through the pyloric ring of the stomach into the duodenum. The second and third portions of the duodenum were dilated and showed evidence of reverse peristalsis. The barium in this loop of bowel did not pass through the old entero-enterostomy stoma, which was suggestive of an obstruction there. A diagnosis of duodenal ulcer and malfunctioning gastro-enterostomy with chronic duodenal obstruction was made and exploratory operation recommended.

While the patient was being prepared for operation a furuncle was discovered in the region of the proposed line of incision. This was opened and a small amount of pus was evacuated. Operation was thus delayed. As the lesion did not heal an exploration was made on March 3, 1936, and a sinus tract was found in the old right rectus abdominal scar. This was explored and proved to be rather extensive. It was lined with granulation tissue and lay across the long axis of the old operative scar and led ultimately through the abdominal wall in the direction of Morrison's pouch. A small amount of pus was encountered. The anterior wall of the portion of the tract through the abdominal musculature was unroofed and packed with iodoform gauze. The patient was discharged from the hospital shortly thereafter to await healing of this old chronic wound infection.

He returned on June 8, 1936, and on June 12, 1936, the abdomen was explored. The scar of the first operation

was excised and the stomach and transverse colon were found adherent to the sac of a postoperative hernia. Numerous loops of small intestine were freed of adhesions and the gastro-enterostomy and entero-enterostomy stomas were at length revealed. The gastro-enterostomy admitted only 1½ fingers but seemed to empty fairly well into the distal jejunal limb, but the proximal limb of the jejunum was twisted and compressed by the middle colic vessels apparently because the anastomosis had been made to their right side rather than to their left. The entero-enterostomy stoma had contracted to such an extent that it was ineffectual in draining the duodenum which was enormously dilated in its second and third portions. Figures 4, 5, and 6 show the probable sequence of events following the original operations. The anterior wall of the duodenum in the first part was scarred and firmly adherent to the under surface of the liver.

The old entero-enterostomy was then enlarged by making a Finney pyloroplasty type of anastomosis between the proximal and distal limbs of the jejunum proximal to the point at which the middle colic artery crossed the two jejunal limbs (Figs. 7, 8, and 9). The hernia was then repaired in the usual manner by imbrication. The patient had a satisfactory convalescence and was discharged from the hospital on July 4, 1936, and has since returned to work. He reported on February 4, 1937, that he has been entirely free of all symptoms since operation and that he is able to do hard labor. The wound is firmly healed and there is no tenderness on deep palpation anywhere in the upper abdomen. On March 8, 1937, the stomach was re-examined with the barium meal (Fig. 3a). The constriction at the gastro-enterostomy was still evident. A fair amount of barium passed through the distal limb of the gastro-jejunostomy loop. The duodenum was no longer dilated and the barium passed through the entero-enterostomy opening with greater ease than before, indicating an enlargement of the stoma. The duodenum was still distorted and painful to pressure but to a lesser degree.

A direct attack was not made on the ulcer itself but our efforts were directed rather toward improving gastroduodenal and jejunal mechanics. There seemed to be no urgent need for taking down the malfunctioning gastro-enterostomy inasmuch as the stomach content passed easily into the duodenum through the pylorus. The prime difficulty lay apparently in the inability of the latter to empty itself. The choice of entero-enterostomy was felt justifiable at the time because it was the more easily performed operation and because it was a much less serious procedure than would have been the case in any attempt to undo the two previous anastomoses. Subsequent events have shown that the results were everything that could have been desired. We are aware that it may be necessary later to deal directly with the ulcer itself. That intestinal obstruction either partial or complete may be caused by the unyielding compression of an adherent vascular pedicle is shown by the occasional reports of congenital anomalies of the duodenum with obstruction at the duodeno-jejunal angle. Judd and White, in 1929, reported 2 such cases in which there was constriction by a band of peritoneum stretching from the superior mesenteric vein for a distance of 3 inches distally. In one of these patients the peritoneal fold only was liberated and in the other a duodeno-jejunostomy was performed with good results.

While we do not pretend to any priority in calling attention to the complication noted in our case, we do believe that the principle of making the approach to the posterior wall of the stomach to the left of the middle colic artery possibly deserves more emphasis than it has hitherto been accorded. The technique of posterior gastro-jejunostomy has been fairly well standardized and the results from a technical standpoint are today reasonably good in most clinics; nevertheless at least 20 different complications due to imperfections in the technique of posterior gastro-jejunostomy have been recorded in the literature. Fortunately the majority of these sequelæ are rarely seen.

CONCLUSION

In performing posterior gastro-enterostomy the transverse mesocolon should be opened in the arch of the vascular arcade of the middle colic artery and to the left of this vessel. The opening should be made in an avascular area at a point close to the duodenojejunal flexure.

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NEPHRECTOMY VERSUS CONSERVATIVE OPERATION IN UNILATERAL CALCULOUS DISEASE OF THE UPPER URINARY TRACT

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STIMULATED by certain recent clinical problems, the question of primary nephrectomy in lithiasis of the upper urinary tract was again raised. In an attempt to answer this query, the late results following nephrectomy and conservative operative procedures were determined. In this institution a systematic follow-up service has been in existence since 1928 following the establishment of a unit history system in 1926. Approximately 85 per cent of the patients who were operated upon because of calculous disease between the years 1928 to 1933, inclusive, have been observed for 1 or more years, and on an average of 4 years.[1]

Following operation, these patients were frequently examined, and x-ray pictures routinely taken at yearly intervals. If the symptoms warranted it, x-ray pictures were taken more frequently or complete urological investigations were performed. While the total number of patients is not large and an average of 4 year follow-up study does not by any means give the ultimate results of operative therapy, it is felt that these observations will in a general way indicate the results of our therapy. Since late recurrences of renal calculi do occur, a 10 to 15 year follow-up study would be a very desirable effort. Even though there are a number of such late cases under observation on this service, there are so many patients of this period who have been lost from observation, that it would be difficult to draw statistical conclusions from such a study.

The postoperative care of the patients included efforts to eradicate renal infection by diet, medication, and sometimes by repeated pelvic lavage. Diets were prescribed after analyses of the calculi were performed in an effort to prevent the hyperexcretion of the known components of the calculi removed. Other diets and medication were used to control, if possible, the hydrogen-ion content of the urine. To prevent recurrence of alkaline stones, acidification was desired and in the patients with uratic stones, alkalinization was carried out.

From the Surgical Service of Dr. Edwin Beer, The Mt. Sinai Hospital, New York, New York.

[1]These statistics are based on follow-up observations which extend up to May, 1936, inclusive.

This study is based on 422 patients with proved renal or ureteral calculi who were admitted to the Ward Service during the 6 years between 1928 and 1933, inclusive. Of these, 312 patients had unilateral calculous disease while 110, or 26 per cent, had bilateral disease. It must be remembered that there were a number of patients (between 30 and 40) each year with symptoms suggesting the presence of renal or ureteral calculi but in whom the diagnosis though suspected was not confirmed. The records of these patients have not been included in this group. If the unproved cases had been included, they would have increased the percentage of unilateral disease and decreased the percentage of bilateral disease.

The term bilateral calculous disease of the urinary tract is often loosely used to denote simultaneous calculi in both kidneys or ureters at the time of observation. In this study, a patient is considered to have bilateral disease when calculi are known to have occurred on either side at any time as judged by the history, by the hospital studies, or by the follow-up observations. For example, although a patient at the time of observation or operation shows evidence of a stone in only one kidney, the past or later history of stone formation on the opposite side leads to the classification of the case as bilateral. In evaluating the statistics of this group of patients, it must be remembered, too, that they were all patients who were sick enough to be admitted to the hospital wards.

In judging the comparative value of conservative operation for renal calculus, the most important questions to be answered are as follows: (1) What is the mortality? (2) What is the likelihood of recurrence of calculi? (3) What is the frequency of residual calculus with further stone formation despite modern technique with operative x-ray control? (4) What are the factors regulating the frequency of recurrence? (5) What is the frequency of later secondary operation?

The statistics from this clinic are somewhat discouraging. Table I contains data concerning 169 conservative kidney operations (both primary and secondary) performed in the above men-

TABLE I.—ALL PATIENTS—UNILATERAL—BILATERAL—ASEPTIC—INFECTED CASES PRIMARY AND SECONDARY OPERATIONS, 1928–1933

Operation	Pyelolithotomy	Pyelonephrolithotomy	Nephrolithotomy	Total conservative kidney operations (a)
Total number operations	91	41	37	169
Mortality Number	4 (b)	2 (c)	6 (c)	12
Percentage	4.4	4.9	16.2	7.1
Not followed	12	2	2	16
Followed	75	37	29	141
Followed less cases with residual stones	67	25	17	109
True recurrence Number	10 (d)	8	5	23
Percentage	14.9	32.0	29.4	21.1
Residual recurrence Number	8 (d)	12	12	32
Percentage	10.6	32.4	41.4	22.7
Total true recurrence and residual Number	18	20	17	55
Percentage	24.0	54.0	58.6	39.0

Note (a). In this tabulation, no consideration has been given to the occasional case in which resection of a portion of the kidney has been performed in addition to the conservative operation.

Note (b). The occurrence of 4 deaths appears to be a high mortality (4.4 per cent) for the rather harmless procedure of pyelolithotomy. An analysis of these cases, therefore, is in order. Sixty patients had a pyelolithotomy performed for a single stone with 2 deaths, a mortality of 3.3 per cent. Thirty-one patients had a pyelolithotomy for multiple or dendritic stones with 2 deaths. Abstracts of these cases follow:

Note (c). Deaths occurred in patients with bilateral dendritic calculi.

Note (d). Pyelolithotomy for single stone was performed on 50 patients. There were no "residual" recurrences and there were 6 true recurrences, or 12 per cent. Pyelolithotomy was performed on 25 patients with multiple (21) and dendritic stones (4) with 8 "residual" recurrences and 4 true recurrences, or 23.5 per cent.

CASE 1. No. 256922. B. K., female, aged 22 years. Solitary right kidney with dendritic calculus and acute pyelonephritis. Patient was in uremia. Pyelolithotomy with decapsulation was performed as a last resort but the patient died. (Also abstracted in text, see Case 9.)

CASE 2. No. 356587. S. M., male, aged 57 years. This patient had tabes dorsalis and residual urine of 30 ounces due to neurological bladder. A left pyelolithotomy was performed for multiple stones in a hydronephrotic kidney. Patient died 21 days later in uremia with a large decubitus ulcer.

CASE 3. No. 291406. E. M., female, aged 68 years. Patient was ill for 2 weeks with chills and fever. A right uretero-pyelolithotomy was performed for unilateral single renal calculus. At operation, a perforated ureter was found with a perinephric abscess. The kidney was decapsulated. The patient died 13 days after operation. Necropsy showed a chronic purulent pyelonephritis, thrombophlebitis of the renal vein, and pulmonary embolism.

CASE 4. No. 312377. L. S., male, aged 32 years. A simple posterior pyelolithotomy for unilateral single stone was performed on this patient. He died 4 days later following immediate and continuous hyperpyrexia. Necropsy did not reveal the cause of death. Sepsis was suspected although the blood cultures were negative.

tioned 6 year period, both unilateral and bilateral, aseptic and infected cases. Of these, 141 operative results were followed.

The indications for these operative procedures on this service are as follows: Pyelolithotomy is performed for single and multiple or dendritic stones situated in the pelvis or in the calyces or in both but easily removed through the pelvis. Pyelonephrolithotomy is performed for numerous stones or dendritic stones which cannot be completely removed through the pelvis and in which additional small and sometimes larger nephrotomies are needed to remove the calculi. The nephrotomy is also sometimes used for purposes of drainage. Nephrolithotomy is performed for large dendritic and multiple calculi which cannot be removed through a pelvic incision and where drainage for infection may be needed, and in all cases in which the kidney cannot be completely mobilized and delivered. In 33 patients, in whom there was a probability of incomplete removal of stones, operation was with x-ray control according to the technique described by Beer (3)[1].

The mortality for pyelolithotomy was 4.4 per cent, for pyelonephrolithotomy 4.9 per cent, for nephrolithotomy 16.2 per cent, and the average for all the operations was 7.1 per cent. The nephrolithotomized patients were, of course, the more acutely ill and had the most advanced calculous disease with infection. In fact the 2 deaths after pyelonephrolithotomy and the 6 deaths after nephrolithotomy all occurred in patients with bilateral dendritic calculi. The seriousness of operation in this type of patient is thus strongly emphasized.

In Tables I and II we have differentiated true recurrences from the residual or pseudorecurrences. The latter are so classified when stones or stone fragments are known to have been present immediately after operation. These data were obtained by routine control x-ray examinations at the time of discharge from the hospital. However, as far as the patient is concerned, the total incidence of true recurrence and residual recurrence is the important factor. The incidence of true recurrence was calculated on the basis of the number of true recurrences in relation to the total number of patients operated upon and followed less the number of patients with proved residual calculi. The incidence of residual or pseudorecurrence was determined on the basis of the number of residual recurrences in relation to the total number of patients operated upon and followed. The true recurrence rates in the total group of patients (Table I) for pyelolithotomy, pyelonephrolithotomy, and nephrolithotomy were, respectively, 14.9 per cent, 32.0 per cent, and 29.4 per cent; the residual recurrence rates were 10.6 per cent, 32.4 per cent, and 41.4 per cent, respectively, while the totals of the true recur-

[1]Since the use of this technique, operative attempts to remove stones have been made in patients who previously would not have been surgically treated or who would have been nephrectomized.

TABLE II

	Total number of	True recurrence	Residual	Total number less residual	Percentage true recurrence	Total number of	True recurrence	Residual	Total number less residual	Percentage true recurrence
	All followed cases (Table I)									
Pyelolithotomy	75	10	8	67	14.9					
Pyelonephrolithotomy	37	8	12	25	32.0					
Nephrolithotomy	29	5	12	17	29.4					
Total operations	141	23	32	109	21.1					
	Single stones					Multiple or dendritic stones				
Pyelolithotomy	50	6	0	50	12.0	25	4	8	17	23.5
Pyelonephrolithotomy	5	0	0	5	0.0	32	8	12	20	40.0
Nephrolithotomy	12	4	0	12	33.3	17	1	12	5	20.0
Total operations	67	10	0	67	14.9	74	13	32	42	31.0
	Stones with clear urine					Stones with grossly infected urine				
Pyelolithotomy	50	5	2	48	10.4	25	5	6	19	26.3
Pyelonephrolithotomy	14	1	5	9	11.1	23	7	7	16	43.7
Nephrolithotomy	8	2	1	7	28.6	21	3	11	10	30.0
Total operations	72	8	8	64	12.5	69	15	24	45	33.3
	Stones unilateral					Stones bilateral				
Pyelolithotomy	50	6	4	46	13.0	25	4	4	21	19.0
Pyelonephrolithotomy	22	4	5	17	23.5	15	4	7	8	50.0
Nephrolithotomy	16	3	3	13	23.1	13	2	9	4	50.0
Total operations	88	13	12	76	17.1	53	10	20	33	30.3
	Stones, kidney good function					Stones, kidney diminished function				
Pyelolithotomy	57	5	4	53	9.4	18	5	4	14	35.7
Pyelonephrolithotomy	13	4	8	5	80.0	24	4	4	20	20.0
Nephrolithotomy	18	4	4	14	28.6	11	1	8	3	33.3
Total operations	88	13	16	72	18.0	53	10	16	37	27.0
	Stones, kidney normal structure					Stones, kidney, structural abnormality				
Pyelolithotomy	50	5	5	45	11.1	25	5	3	22	22.7
Pyelonephrolithotomy	14	3	4	10	30.0	23	5	8	15	33.3
Nephrolithotomy	10	3	2	8	37.5	19	2	10	9	22.2
Total operations	74	11	11	63	17.4	67	12	21	46	26.1
	Stones, primary operation					Stones, secondary operation				
Pyelolithotomy	74	10	8	66	15.1	1	0	0	1	0.0
Pyelonephrolithotomy	33	7	11	22	31.8	4	1	1	3	33.3
Nephrolithotomy	16	3	3	13	23.1	13	2	9	4	50.0
Total operations	123	20	22	101	19.8	18	3	10	8	37.5

rence and residual rates were 24.0 per cent, 54.0 per cent, and 58.6 per cent, respectively. These rather horrifying figures show the importance of controlling the residual calculus situation besides the problem of true calculus recurrence. This frequency of "left over" calculi was emphasized by Barney some years ago.

The report of Cabot and Crabtree, in 1915, contained statistics which were very disconcerting. Following 66 conservative kidney operations for stone, they found that 49 per cent of the patients were not well. Since this time many reports have appeared in the literature. Unfortunately, some of these do not indicate in detail exactly how the statistics were arrived at. Unless one knows the type of material studied, the duration of the follow-up, the percentage of cases followed, whether questionnaire or personal and roentgenographic check-up were employed, whether or not allowances have been made for residual calculi, etc., it is difficult to evaluate the reported results. At the Congress of the International Society of Urology at Rome in 1924, a symposium was presented on the late results of the operative treatment of renal calculi. DeIllyes has published a comparative table of the collected statistics of these and other authors.

Because the percentage of recurrences in our series is high as compared with other recent statistical studies, the possible reasons therefore should be discussed. In the first place the patients have been very carefully and personally observed

for an average of over 4 years. We have been very liberal in judging of recurrences. Thus, if a patient after operation gives a history of colic on the same side with the passage of a stone, the patient is considered to have had a recurrence even though the x-ray examinations are negative and the patient is well. The patients have been subjected to frequent follow-up x-ray examinations so that recurrences have been frequently discovered in patients who were completely asymptomatic. These statistics are higher, too, because the indications for conservative operation have been extended to patients who in previous years would have been nephrectomized or not operated upon at all. The method of calculating the percentage recurrence on the basis of the total number of patients operated upon and followed less those with proved residual or overlooked fragments or stones makes the rate higher than if the basis were the total number of patients operated upon alone. However, this is necessary since we have no way of knowing what would have happened to the patients with residual recurrences if these had not been present. Eighteen of the 141 patients followed after operation had had secondary operations on the same kidney. Seventeen patients had had multiple operations either on the same kidney or the opposite one. Included in these are 7 patients with so called "malignant calculous disease." These patients statistically considered elevated the recurrence rate since they showed recurrences after each of their 2 operations, and, in one patient, 3 operations. It must be emphasized, too, that only ward cases have been used in this study, or patients in the lower social strata who have not been able to look after themselves properly and who have sought advice late in their illness. Our impression is that the results among our private patients are much better.

The value of the technique of operative x-ray control in this particular group of patients must be recognized. It must be realized that the patients in whom operative x-ray control was carried out usually presented more complicated cases than those in whom it was not used, except in cases of nephrolithotomy in which the kidney could not be delivered to do an x-ray control. Of 74 patients with multiple or dendritic calculi, operative x-ray control was performed in only 33, or 44.6 per cent. At the present time, this technique is employed in a greater percentage of these cases. While the percentage of residual calculi was somewhat less in the group of patients in whom operative x-ray control was performed than in those without x-ray control, the real advantage of this procedure is apparent on consideration of the following: 33 patients had operative x-ray controls. In 15, stones or stone fragments which could not be palpated or found without the x-ray were located and removed. In 10, although stone fragments were seen on the x-ray control plate, they could not be located and removed. It must be remembered that in several cases further exploration and x-ray procedures were contra-indicated by the seriousness of the patient's general condition while on the operating table. X-ray control showed no stones or fragments remaining in the kidney in 22 patients. This was proved to be correct in 19 patients and incorrect in 3 as verified by postoperative x-ray pictures taken on discharge from the hospital ("discharge x-ray control").

Table II classifies the recurrences (true recurrences) according to various factors for purposes of comparison: For example, with single stones, the recurrence rate after pyelolithotomy is 12.0 per cent, while with multiple or dendritic stones it is 23.5 per cent. The uninfected or slightly infected cases which are classified as stones with clear urines carry an average recurrence rate of 12.5 per cent for a total of all operations performed, which is contrasted with a recurrence rate of 33.3 per cent in cases with grossly infected urines. When the calculous disease is unilateral, the operation a primary one for single stone with clear urine, and the kidney is relatively normal in structure with good function, the recurrence rate is lower, i.e., about one-half of the recurrence rate when the opposite set of conditions prevail. It is realized that, although tabulated separately, these factors often are naturally associated, sometimes as cause and effect. Thus, stasis of the kidney with hydronephrosis will show diminished function and possibly gross infection.

With reference to the recurrence rate in relation to the chemistry of the removed calculi, for all operations the true recurrence rate for calcium oxalate or calcium oxalate-calcium phosphate stones is 8.1 per cent while for the secondary mixed calculi it is 28.3 per cent. As regards uratic calculi, it is difficult to know whether any stone fragments have been overlooked since they are radio-transparent. Hence it is impossible to differentiate between true and residual recurrence with this type of stone.

The frequency of secondary operation following conservative operative procedure for renal calculi should be noted. Of the 141 patients followed, subsequent secondary operations were performed on 31, or 22.0 per cent of the original number. Of these 31 operations, 16 were secondary conservative operations while 15 were nephrec-

tomies. In other words, 10.6 per cent of the followed number of conservative operations required a subsequent nephrectomy. Thirteen followed a primary operation while 2 followed secondary operations. The indications for the 15 nephrectomies were: pyonephrosis with or without calculi, 9; chronic pyelonephritis, 1; persistent fistula, 4; and tuberculosis, 1. There were 55 patients, or 39.0 per cent, of the 141 who had either a true recurrence or a residual recurrence. It should be pointed out that a small number of patients with recurrence required secondary operation but refused. Six of the above mentioned 31 secondary operations were for conditions other than recurrence. On the other hand, it should be stressed that many patients with recurrence or residual recurrence were perfectly well, asymptomatic, and presented no indication for further operation.

Nephrectomy for calculous disease of the kidney or its complications was performed in 51 patients, or 12.1 per cent, of the 422 patients of this series, while conservative renal operations were performed on 169 patients, or 40.0 per cent. Seventy-three patients had a ureterolithotomy performed while the remaining number had either non-operative (such as cystoscopic) treatment or no treatment at all.

As judged by other reports, such as that of Priestley (26.2 per cent), nephrectomy has not been done as frequently here as elsewhere. It has always been felt, in this clinic, that conservatism which usually means conservation of renal tissue should be the guiding consideration in the treatment of renal calculi, especially in bilateral disease. Because of the reported high incidence of bilateral disease, nephrectomy in lithiasis has been performed only as a procedure of last resort even in unilateral cases.

Four patients died after the 51 nephrectomies, a mortality of 7.8 per cent. Of 34 patients on whom a primary nephrectomy was performed for an infected worthless kidney incident to calculous disease, 3 died, a mortality of 8.8 per cent, while in the group of 17 patients who had secondary nephrectomies performed, 1 died, a mortality of 5.0 per cent. There were 34 patients with unilateral and 17 patients with bilateral disease who were treated by extirpation, 4 of the former and none of the latter died after operation.

The mortality of 7.8 per cent appears high as compared with a report of Beer (2) from this hospital in 1920. He had only 1 death after nephrectomy in a group of 49 patients with extensive destruction of the kidney due to suppuration with or without stone, or a mortality of 2.03 per cent. Because of the present higher mortality, it is interesting to review briefly in abstract the histories of the patients who died.

CASE 5. No. 294200. S. F., male, aged 55 years, presented renal symptoms of 1 month's duration. He had multiple stones in the left kidney and a single obstructing left ureteral stone. He died 36 hours following a left nephrectomy for atrophic kidney with multiple calculi.

Postmortem findings: unrecognized subacute bacterial endocarditis.

CASE 6. No. 289280. W. G., male, aged 35 years, presented a history of symptoms of 3 years' duration. He had undergone 3 operations as follows: March 13, 1926, right pyelolithotomy; October 22, 1926, left pyelonephrolithotomy; April 3, 1928, secondary left nephrectomy for left pyonephrosis with ureterocolic cutaneous fistula.

Postmortem findings: stercoraceous retroperitoneal phlegmon; fistulas from descending colon and left ureter into phlegmon; phlebitis of left renal vein; right pyonephrosis; left ureteral calculus.

CASE 7. No. 348140. A. M., female, aged 43 years, presented urinary symptoms of 7 years' duration. A right nephrectomy for calculous pyonephrosis was performed. Death followed operation from hemorrhage and shock.

CASE 8. No. 292169. E. M., female, aged 63 years, presented urinary complaints of 20 years' duration. A left nephrectomy for calculous pyonephrosis was performed. Death occurred 14 hours after operation, probably from cardiovascular collapse.

It will be seen that only 2 of these 4 patients had a simple primary nephrectomy performed for calculous disease of the kidney. Of the remaining 2, 1 had a complicated secondary nephrectomy and the other was operated upon because of a mistake in diagnosis.

In deciding the question of nephrectomy versus conservative operation in renal calculous disease, there can be no argument as to the advisability of extirpation in those unilateral cases in which the kidney is completely or almost completely destroyed by calculous disease with infection with no hope of return of function and in which the kidney is a permanent source of danger. The problem repeatedly arises, however, as to what procedure to use in certain borderline cases. A case with unilateral disease may present the following conditions either singly or in combination:

1. The kidney is considerably destroyed.
2. Extensive dilatation and deformation have taken place with the possible persistence of uncontrollable infection and residual urine in calyces and pelvis inviting recurrence.
3. Multiple or dendritic calculi are present which perhaps cannot be completely removed even under x-ray control and may serve as nuclei for further trouble.
4. Because of general and local symptoms, the kidney though possessing some function may cause chronic invalidism.

In these difficult borderline cases, will the individual be better served by a drainage operation

with removal of calculi (pyelonephrolithotomy or nephrolithotomy) or by the more radical procedure of nephrectomy? To decide this problem, the following factors should be considered.

1. The mortality of the respective procedures.
2. The frequency or liability of the patient to have difficulty with the same kidney in the case of a conservative procedure.
3. The frequency of secondary nephrectomy after conservative operations.
4. The frequency of complications and sequelæ following these procedures and the duration of convalescence with relation to the patients' economic status.
5. The frequency of bilateral nephrolithiasis and involvement of the second kidney by calculous disease after nephrectomy or conservative operation on the first kidney.

The following is a detailed presentation of the above mentioned factors which I believe should be taken into consideration.

1. In this series there was no mortality after pyelonephrolithotomy in 22 cases and nephrolithotomy in 16 cases of unilateral disease. The mortality for pyelolithotomy for multiple or dendritic stones in 31 cases was 6.4 per cent. Because of the small number of cases, these figures probably do not represent a true picture of the mortality. The statistics from Table I (all cases) may be nearer the true mortality rates for a larger group of cases. This is shown by Joly who, summarizing the collected statistics reported by Cifuentes, Braasch, Brongersma, and Gian Vito Tardo, at the above mentioned Congress held in 1924 found: for pyelolithotomy, 1,398 cases with 34 deaths, or 2.4 per cent; for nephrolithotomy, 2,045 cases with 212 deaths, or 10.3 per cent; and for nephrectomy, 1,822 cases with 154 deaths, or 8.4 per cent. While the mortality for primary nephrectomy in this series was 8.8 per cent it is likely that with properly selected cases (Case 1, error in operative indication; Case 2, complicated case with ureterocolic cutaneous fistula), the mortality is lower. At any rate, the mortality of the contrasting procedures is comparable and not of decisive import in unilateral disease.

2 and 3. The frequency of the total recurrence and residual recurrence in our carefully checked up cases is large. It is approximately 40 per cent for pyelonephrolithotomy and nephrolithotomy in unilateral cases. More than one-third of the patients with recurrences are well and asymptomatic. Approximately 20 per cent of the total number of patients operated upon need secondary operations of which approximately one-half require nephrectomy for recurrence, infected worthless kidneys, or persistent fistulas. The results following pyelonephrolithotomy and nephrolithotomy are obviously poor. At least with removal of the kidney, recurrences and further operation for stones are impossible.

4. Even without complicated statistical data, it will be conceded that primary nephrectomy is usually a simple procedure and gives less postoperative complications than pyelonephrolithotomy or nephrolithotomy. The convalescence is usually much smoother; urinary leak or persistent fistulas, and postoperative renal hemorrhage are absent. Febrile reactions due to residual infection in a diseased kidney, i.e., pyelonephritis, and phlebitis of the renal vein are not present. Incidentally, 4 of the secondary nephrectomies performed were for persistent fistulas[1] in infected kidneys following conservative operations. Besides a smoother convalescence, the average stay in the hospital is shorter after nephrectomy. This is important from an economic standpoint.

5. It has been noted above that bilaterality was mentioned in 26.0 per cent of the 422 case histories analyzed. The criteria for classification of a case as bilateral have been stated above. More important than the actual percentage of bilaterality is the question as to how many cases thought to be unilateral when first studied showed involvement of the opposite kidney at a later date. Of 130 patients operated upon for renal calculi with follow-up studies of from 1 to 7 years who were diagnosed as unilateral cases on first admission, 19, or 14.6 per cent, later presented evidences of calculous disease on the opposite side. The second kidney became stone-bearing in 13 patients, or 15.1 per cent, of the 86 patients who had conservative operations performed on the first kidney. Of 27 patients who were nephrectomized for supposedly unilateral disease and who were followed on an average of 4 years, 4, or 14.8 per cent, developed definite evidences of stone in the other kidney or ureter. However, in only one instance (Case 9), or 3.7 per cent, was this involvement of the remaining kidney contributory to a fatal outcome.

CASE 9. No. 256922. B. K., aged 22 years, presented a history of 1 year's duration. She had multiple stones in her left kidney for which a pyelolithotomy was performed. One month later, a secondary nephrectomy for persistent lumbar sinus due to stricture at the pyelo-ureteral junction was performed. Seven months later the patient developed dendritic stone in the right kidney with acute pyelonephritis. Pyelolithotomy with decapsulation was performed but the patient died in uremia.

[1]None of these fistulas was caused by overlooked stone fragments slipping into the ureter—since it is a routine procedure on this service to place a temporary ligature around the upper ureter when operating on a stone kidney.

In this series, then, involvement of the opposite kidney by calculous disease following nephrectomy for unilateral disease occurred in approximately the same frequency as involvement following conservative operations. Most observers report an infrequent involvement of the second kidney after nephrectomy. Brongersma found that following primary nephrectomy for unilateral calculous disease, involvement of the opposite side occurred in only 1 case out of 53, or approximately 2 per cent. Braasch and Foulds found this occurrence to take place in 3 per cent of the cases, Twinem in 4.2 per cent, Rafin in 3 per cent while Winsbury-White found no subsequent stone formation on the opposite side in the 43 patients with unilateral disease upon whom he performed a nephrectomy. Winsbury-White advises nephrectomy in many cases of unilateral stone, to insure against pyuria, formation of stone in the second kidney, and continued ill health. Joly, in a discussion on calculous anuria, quotes Eliot who found that 23 out of 32 patients (i.e., .72 per cent) with calculous anuria had the opposite kidneys removed for calculous pyonephrosis. Despite this excellent indication in favor of conservative operative treatment, he argues for earlier nephrectomy stating that recurrence on the opposite side is uncommon after nephrectomy for stone and is usually found only when the infection has spread from the first to the second kidney. Of 377 patients with calculous anuria, Cahill tabulated 128, or 33.9 per cent, whose opposite kidney was absent, removed, or aplastic. Herman and Greene found that while calculous anuria occurs seldom after nephrectomy for conditions other than calculous pyonephrosis, it is rare if the remaining kidney is normal at time of original operation. There have been very few cases of calculous anuria seen on this service. This is believed to be due to the extreme conservatism which has been shown in the operative management of our cases.

It is difficult to understand why patients with unilateral disease who have been nephrectomized show subsequent involvement of the opposite side so infrequently when the acknowledged incidence of bilaterality is so much higher (15 to 30 per cent). Whatever the factors are in stone formation, one would think that nephrectomy for calculous disease would not change these factors. More in line with our statistics are those of Hellström and Cifuentes. Hellström found in his previous material that there was between 10 per cent and 11 per cent involvement of the second kidney after nephrectomy and between 6 per cent and 15.5 per cent involvement after conservative procedures. After nephrectomy for staphylococcus stones, the opposite side was affected in 16.7 per cent. From these figures he argues in favor of conservative operation and states that nephrectomy is to be avoided at any price. Cifuentes, who noted bilateral disease in 20 per cent of his patients also had a 13 per cent appearance of lithiasis in the second kidney after observation or operation had been performed on the assumption that the disease was unilateral.

Concerning the involvement of the solitary kidney by unrelated disorders following nephrectomy for calculous disease, there is no evidence that such involvement occurs in any greater frequency than in people who have both kidneys. It is, of course, well known, that the loss of one kidney is usually of no great significance *per se*. Depending on the experimental animal used it has been found that as little as one-sixth the normal kidney tissue suffices to sustain life (14).

Summarizing, in the borderline type of case as has been outlined, nephrectomy is advised by many because the mortality is not higher, and one can thus avoid the high incidence of recurrence and residual recurrence, complication, and secondary operations with prolonged convalescence and subsequent economic loss found after the alternate conservative operative procedure.

The main objection to nephrectomy in unilateral calculous disease is that once a kidney is removed, it can no longer serve the patient, who, because of subsequent difficulty with the remaining kidney, may be in dire need of some additional excretory function. Of these patients 14.8 per cent developed calculi on the opposite side.

The fallacy committed in judging what procedure should be used on the basis of a statistical study is obvious. One never can be sure into what statistical group the individual patient under consideration will fall. While nephrectomy may be the method of choice in a majority of questionable cases, as determined by many considerations, it could not be so considered if subsequently, the patient should require additional excretory function due to serious calculous involvement of the previously normal kidney. While such later involvement is not common, it does occur and often when least expected. It has been the experience of this group (4), that on various occasions, conservative operation on a badly diseased stone bearing kidney has paid great dividends when later involvement of the second kidney or ureteral blockade made the first kidney the sole excretory urinary organ. In addition, an astonishing improvement in function has been observed by almost all surgeons

after adequate drainage and conservative treatment of such a kidney.

SUMMARY AND CONCLUSIONS

The true recurrence rates in all types of cases for pyelolithotomy, pyelonephrolithotomy, and nephrolithotomy were, respectively, 14.9 per cent, 32.0 per cent, and 29.4 per cent while the total rates of the true recurrences plus the residual recurrences were 24.0 per cent, 54.0 per cent, and 58.6 per cent, respectively. In unilateral cases, the true recurrence rates were 13.0 per cent, 23.5 per cent, and 23.1 per cent, respectively. The true recurrence rate for all conservative operations in the primary stone cases (calcium oxalate or calcium oxalate-calcium phosphate) was 8.1 per cent while for the secondary stone cases (mixed calculi—salts of alkaline earths) it was 28.3 per cent.

Of 141 patients followed on whom conservative operations were performed, 55, or 39.0 per cent, had either a true recurrence or residual recurrence, while of 88 patients with unilateral disease, 25, or 28.4 per cent, had either a true or residual recurrence. Not all of these patients had symptoms because of their recurrences. In fact, the majority gave no evidence of trouble until roentgenograms were taken. There were 31 secondary operations performed or 22.0 per cent of the original number. Of the total number 15, or 10.6 per cent, required secondary nephrectomy The total incidence of bilaterality in this series was 26.0 per cent. Of the patients with unilateral disease 14.6 per cent had subsequent calculus formation on the second side after the original observation and diagnosis of unilateral disease, 14.8 per cent followed nephrectomy, 15.4 per cent followed pyelolithotomy, 9.5 per cent followed pyelonephrolithotomy, and 23.1 per cent followed nephrolithotomy. While involvement of the second kidney after nephrectomy for unilateral disease is unusual as judged by the majority of reports in the literature, our statistics show that it may occur more frequently.

Notwithstanding several considerations suggesting the advantages of primary nephrectomy in certain borderline cases of unilateral calculous disease of the kidney, it is believed that pyelolithotomy, pyelonephrolithotomy or nephrolithotomy with operative x-ray control are procedures of choice and that conservatism should still be the main desideratum in the primary treatment of this condition. It is also felt that the results of the conservative procedures will improve with improvement of operative technique and x-ray technique (both pre-operative and operative), and with the use of such post-operative measures as possibly the high vitamin acid ash diet. The future will certainly bring to light additional aids in the technique of the operative procedures and in the prevention of recurrences, whether true or residual. Unfortunately, once a kidney has been removed, it can never be replaced; therefore every effort should be made to conserve it.

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THE INDICATIONS FOR VAGINAL HYSTERECTOMY

H. D. COGSWELL, M.D., Tyler, Texas

VAGINAL hysterectomy is not a new operation, but it received scant attention until about 30 years ago. At that time Price of Philadelphia popularized it by leaving heavy clamps on the broad ligaments for 48 hours. This technique has lost favor since the advent of the Mayo operation which gives the bladder support and unites the broad ligaments in the midline by ligatures. The operation has had transient periods of popularity. Abdominal hysterectomy, on the other hand, has constantly been a dependable procedure maintaining its solid position as the operation of choice.

During the past few years the literature has contained many articles advocating more vaginal hysterectomies, increasing the indications, and giving statistics stressing the low mortality rate. Tyrone writes, "the indications . . . have gradually extended until . . . it is the accepted procedure in approximately one-half of the cases in which hysterectomy is necessary." Black recommends vaginal hysterectomy "with the full expectation that a few trials . . . will prove its merit and warrant its more general use." Heaney reports 627 vaginal hysterectomies with but 3 deaths, and states: "There has never been reported a series of hysterectomies by the abdominal route with so low a mortality rate." In a statistical study by Harris it was found that the mortality rate for vaginal hysterectomy was 2 per cent lower than for abdominal hysterectomy.

With such encouraging reports in the literature and the enthusiasm shown by advocates of vaginal hysterectomy, one is led to believe that this operation is to be chosen whenever possible. It was noted that the convalescence of patients who had undergone this operation was not as uneventful and uncomplicated as a perusal of the literature would lead one to believe. It was noted, generally, that the mortality rate was low but that the morbidity was higher than after abdominal hysterectomy. The younger patients did not have as smooth a convalescence as the older patients and had the more serious complications. It was also observed that many times technical difficulties arose which could not be foreseen and made the operation more hazardous than even a poorly performed abdominal hysterectomy.

From the Gynecological Service of the Indiana University Medical Center.

It was thought that a comparative study made between vaginal and abdominal hysterectomies might show the cause of the existing inconsistencies. The patients studied were operated upon by a group of 11 surgeons, with enough difference in skill and experience to give results which should be those of an average surgical service. The operative technique varied to some extent, but all the surgeons did some modification of the Mayo operation.

A total of 179 consecutive vaginal hysterectomies was compared with 200 consecutive abdominal hysterectomies. In the abdominal group there were 108 supracervical hysterectomies and 92 panhysterectomies. The series were both large enough to permit a fair comparison. No cases were omitted in either the vaginal or abdominal series as it was felt that every case should be included to get an accurate idea of the relative values of the two operations. Each patient's postoperative days of morbidity were counted and averaged. Due to the observation that the more senile patients had the less severe convalescence, the patients were placed in age groups for comparison. The standard of morbidity used was a temperature of 100.5 degrees F. or over, beginning with the first day after operation. The morbidity of patients weighing 160 pounds or over in the two groups was compared.

An attempt was made to compare the urinary complications. Those patients who received medication (urotropin, ammonium chloride, tincture of hyoscyamus, mandelic acid, sodium citrate, etc.) for the relief of genito-urinary complaints were recorded and compared. A comparative study was also made of postoperative complications. The mortality of the two groups was noted and the cause of death ascertained in each case by a postmortem examination (Table III).

Table I shows the days of morbidity in the different age groups. There was little difference in the days of morbidity between the two types of abdominal operation, averaging 2.9 days. Vaginal hysterectomies averaged 4.7 days of morbidity. Rinsman and Sellers observed that morbidity was more prolonged in the vaginal type of hysterectomy. Witherspoon and Butler also found this true and found that these patients had the longest hospital stay. In the age group of 50 to

TABLE I.—AVERAGE POSTOPERATIVE DAYS OF MORBIDITY IN THE AGE GROUPS

Type of operation	Age, years 20–30	Age, years 30–40	Age, years 40–50	Age, years 50–70	Total average
Abdominal panhysterectomy	2.0	4.0	3.0	2.8	2.9
Supracervical hysterectomy	2.2	3.2	2.9	3.5	2.9
Total abdominal hysterectomy	2.1	3.6	2.9	3.1	2.9
Total vaginal hysterectomy	4.6	4.5	6.2	3.3	4.7

70 years it is seen that the average morbidity in the vaginal type of hysterectomy is practically the same as that of the abdominal operation, and this is the only age group the morbidity of which can compare with the abdominal series. Every patient in this group was operated upon for the cure of procidentia.

Postoperative urinary complications were most common in the patients who were operated upon by the vaginal procedure, 45 per cent of whom received urinary medication as compared to 25 per cent in the abdominal cases. Harris reported similar findings in his series.

A list of the postoperative complications is shown in Table II. It is difficult to evaluate a comparison such as this, but it is obvious that the complications in the one group are balanced by similar complications in the other group. The abdominal operations, however, were done on the most difficult and complicated cases while the vaginal hysterectomies were all done on carefully selected patients. It is logical to assume that due to the moribund condition of some of the patients who were operated upon by the abdominal procedure, the complications in this group should be expected to be more numerous and severe. Since the two series do balance so evenly it is strong evidence that an abdominal hysterectomy is the safer and is fraught with fewer postoperative complications than a vaginal hysterectomy, excluding cases of procidentia.

Wishard and Megenhardt made a study of the residual urinary symptoms and cystoscopic findings in these same patients. They found that the highest incidence of persistent symptoms is present in those patients who have had vaginal hysterectomies. This is consistent with the complaints registered by the patients examined in the postoperative gynecological clinic. In general, the younger patients had the greatest number of residual symptoms. Next to bladder discomfort these patients complained of pain in the lower quadrants which was interpreted as being due to tension on the supporting pelvic ligaments. It was observed that patients who had been operated upon by the vaginal route for procidentia had the fewest residual symptoms and were the more consistently relieved of their pre-operative complaints.

Table III gives the mortality rate and cause of death as confirmed by autopsy. The abdominal group had a mortality of 1.5 per cent compared to 0.5 per cent for the vaginal group. Vaginal hysterectomies, as stated, were performed on selected and uncomplicated cases. If abdominal hysterectomies had been done in place of vaginal operations on these patients, it is most probable that the mortality rate would have been just as low. The 3 patients upon whom the abdominal operation was performed who died had peritonitis, 2 of them presented difficult conditions in which the bowel was unknowingly opened and 1, upon whom a total hysterectomy was performed, had a pre-existing cellulitis of the vagina. All of these patients presented technical difficulties which made a vaginal hysterectomy impossible. Two patients had old pelvic infections which caused adherence of the pelvic viscera to the intestine and the remaining patient presented an impacted fibroid.

Seventy-eight patients with procidentia were treated by vaginal excision of the uterus and repair of the rectocele and cystocele when present. There were 49 patients in the age group of 50 to 70 years who were operated upon for procidentia, and 29 patients in the age group from 31 to 49 years. In the older group the morbidity was 3.3 days and in the younger 3.6 days. The average morbidity of patients with procidentia was 3.45 days, and this group of patients had the most uneventful convalescence, fewest complications, and the greatest amount of relief when examined 3 months after operation. With the good results obtained in these patients it is evident that a vaginal hysterectomy is a safe, curative treatment in cases of uterine prolapse with the associated cystocele and rectocele, irrespective of the patient's age. Richardson (9) states, "vaginal hysterectomy possesses distinct advantages over . . . the abdominal route in properly selected cases" and further adds (10), "an attempt to broaden the scope of the vaginal operation beyond reasonable

TABLE II.—NUMBER OF PATIENTS IN EACH GROUP WITH POSTOPERATIVE COMPLICATIONS

Complications	Abdominal panhysterectomy	Supracervical hysterectomy	Abdominal hysterectomy, total	Vaginal hysterectomy, total	Per cent	
					Vaginal	Abdominal
Wound infection	9	7	16	17*	0.9	0.8
Circulatory collapse	0	1	1	0	0.0	0.05
Pyelitis	1	5	6	5	0.28	0.3
Peritonitis	3	1	4	1	0.05	0.2
Rectovaginal fistula	0	0	0	1	0.05	0.0
Eventration of the wound	0	1	1	0	0.0	0.05
Postoperative hemorrhage	2	1	3	3	0.16	0.15
Pelvic abscess	3	0	3	6	0.33	0.15
Thyroid crisis	1	0	1	0	0.0	0.05
Vesicovaginal fistula	2	0	2	2	0.11	0.1
Parotitis	1	0	1	0	0.0	0.05
Toxic encephalitis	1	0	1	0	0.0	0.05
Phlebitis	0	0	0	1	0.05	0.0
Pulmonary embolism	0	0	0	1	0.05	0.0
Fecal impaction	0	0	0	2	0.11	0.0

*Abscess in roof of vagina.

limits makes it a mutilating procedure which serves only to discredit it and denotes neither sound judgment nor safe surgery."

The most common indications given by different writers for performing a vaginal hysterectomy were noted and were used in this series in an attempt to prove or disprove their justification. They are: (1) elderly patients who are bad risks, (2) malignancies of the cervix, (3) laceration and infection of the cervix, (4) fibroids and fibrosis of the uterus, (5) procidentia, (6) obesity. In the series studied all the elderly patients were operated upon by the vaginal route for the same condition, procidentia. Since the only other common need for pelvic surgery in the senile is pelvic tumors, which certainly should be removed by the abdominal route, it was thought that the first indication could be omitted. Malignancies of the cervix were formerly treated by total hysterectomy, but recent reports (13) reveal that the prognosis is much brighter when radiation is substituted for surgery. This is consistent with the results obtained in this clinic. Lacerations and infections of the cervix can be cured much more conservatively (2, 3) than by a vaginal hysterectomy, and there is no indication for such radical treatment. The hackneyed argument of carcinoma originating in the remaining cervical stump is still moot, but recent papers show this possibility to be negligible (5, 12).

If a vaginal hysterectomy could be done with ease in an obese individual, it would certainly be preferred to an abdominal operation. Surgery through a fat abdominal wall with a thick, bulky omentum always makes any operative procedure more difficult and is attended by a greater danger of postoperative hernia, but it is often impossible to determine the presence of masses or fixation of the pelvic viscera when examining a fat individual. The morbidity in the obese was higher in the vaginal series than in the abdominal. There was no death in either group (Table IV).

The perils encountered in a difficult laparotomy on an obese individual cannot compare with those present in a poorly selected vaginal hysterectomy. If it can be definitely determined before the op-

TABLE III.—MORTALITY RATES IN SERIES

Type of operation	Number of deaths	Autopsy findings
Panhysterectomy	2	Peritonitis
Supracervical hysterectomy	1	Peritonitis
Vaginal hysterectomy	1	Pulmonary embolism
Abdominal	1.5%	
Vaginal	0.5%	

TABLE IV.—MORBIDITY OF PATIENTS WEIGHING 160 POUNDS OR MORE

	Abdominal hysterectomy	Vaginal hysterectomy
Number of patients	34	17
Average weight	182	174.8
Average morbidity	4.3	6.05
Mortality	0	0

eration that there are no abdominal tumors and that the uterus and adnexa are not fixed so that the uterus can be prolapsed with some traction, the indications for a vaginal hysterectomy may be present. Two cases were encountered in which, at the time the vaginal hysterectomy was performed, pelvic disease which had not been suspected was found, and could not be dealt with because of its inaccessibility. Three patients, or 8 per cent, in the obese abdominal group developed hernias after operation. In every patient in whom a hernia occurred contra-indications for a vaginal hysterectomy were present. It would seem that an abdominal hysterectomy on a corpulent individual is still safer than the average vaginal operation, except in cases of procidentia.

Morcellation may be required in order to remove a fibroid of the uterus by the vaginal route. This procedure has been advocated by several writers. Larkin seems to have a sane and conservative view on this practice when he states: "Morcellation which is advocated is a dangerous procedure. One never knows when a benign appearing fibroid or supposedly benign cyst is harboring a malignant cancer." One vesicovaginal fistula in this series was due to delivering a fibroid uterus of such large dimensions through the vagina that a portion of the bladder was torn away. There can be no argument that an abdominal operation is to be chosen by the average surgeon in removing a uterine myoma unless it is so small that its diagnosis is difficult. Vaginal hysterectomy for the removal of fibroids had the highest mortality rate of any type of hysterectomy in the series reported by Harris.

CONCLUSIONS

1. Prolapse of the uterus is the only indication for a vaginal hysterectomy.

2. The morbidity is higher in vaginal hysterectomy than in abdominal hysterectomy, except in procidentia.

3. The smoother convalescence of older patients upon whom a vaginal hysterectomy was performed is explained by the fact that all the patients in this group were operated upon for procidentia.

4. Excluding cases of procidentia, the postoperative complications and complaints are more numerous in the vaginal group than in the abdominal group.

Note.—I wish to thank Dr. W. D. Gatch for his aid and suggestions in the preparation of this paper.

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EDITORIALS

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DECEMBER, 1937

THE JUSTIFICATION FOR STAGE SURGERY IN TOXIC THYROID DISEASE

AN INCREASING experience with thyroid disease should make one increasingly wary of generalizing concerning it, and it might seem that surgeons from regions in which goiter is non-endemic should refrain from such generalizations altogether. Yet even a rather limited experience permits the comprehension of tendencies, and one tendency seems fairly clearcut today, the use of the stage operation for toxic thyroid disease on rather shadowy indications.

Hertzler has very correctly said that while it is no disgrace to do in two stages what could have been done in one, to reverse the procedure and lose the patient is a very different story. That does not grant, however, a license for stage surgery in the absence of definite indications. With all its advantages, the two-stage or more than two stage operation can be overdone, and has all the defects of its merits. There are other considerations, aside from the general principle that less surgery is always safer than more surgery. Every anesthetic, for instance, however skillfully given, implies a certain risk, minimal, it is true, but none the less present and not to be lightly waved aside. Every operation, however skillfully performed, has inherent in it certain risks—infection, hemorrhage, shock, embolism, nerve injuries, and similar predictable and unpredictable dangers and catastrophes. Every convalescence may possibly go astray. The patient who is submitted to stage surgery is given an additional safeguard from the standpoint of his toxic thyroid disease. That cannot be gainsaid. But it also cannot be gainsaid that he runs a double anesthetic and a double surgical risk. In certain cases that double risk is more than justified. In other cases the justification is at least debatable, with perhaps as much to be said on one side as on the other. But in some instances, and we are beginning to believe that the number is rather larger than is generally realized, the risk is not justified at all.

The question of when stage surgery is warranted in toxic thyroid disease rests first of all upon the premise that the supposed toxic disease is really toxic, and then upon the degree of toxicity. Of the justification for stage surgery in true toxic thyroid disease there can be no possible doubt. Every clinic which practices it has proved that point again and again, just as every surgeon who does not practice it has proved the point by the reverse method, the cases he has lost, the patients who should not have died. But that all patients on whom stage surgery is done are very toxic, or, to speak frankly, are toxic at all, we do not for a moment believe.

Lord Horder has recently and properly com-

mented upon the madness which seizes us all when the word thyrotoxicosis is bandied about, and has said that, if we must use it, the least we can do is to see that we are not mesmerized by it. His warning might well be heeded in any surgical community. Whether it is the tendency of all internes and all young doctors, as well as many older ones, to paint the picture of Graves' disease in all cases of goiter we do not know, but personal experience and the reading of the literature force us to the conclusion that the tendency is rather general. The historian who begins his anamnesis with the textbook picture of Graves' disease in his consciousness is likely to emerge from the endeavor with that same picture on the record, whether it should be there or not.

That the differentiation between toxic and non-toxic thyroid disease is always easy we do not for a moment claim. The taking of a history in such cases is often fraught with difficulty. Too many patients are prone to exaggerate their symptoms and to furnish any suggested to them. Too many patients seem unable to reply to any question as to their illness except in the affirmative. But it takes more than nervousness, it takes more than a story of palpitation, it takes more even than the visible evidence of a tremor to justify the diagnosis of toxic thyroid disease.

The mere presence of protuberant eyes does not establish the existence of exophthalmos. Many persons are born with such an abnormality and a simple question as to the duration of the supposed pathological change very frequently eliminates it entirely by the revelation that it has been present from birth. A high basal metabolic rate, in the absence of other signs and symptoms, is no evidence of anything. The time has long since passed when a single high reading, or even repeated high readings, would be regarded as of independent diagnostic value. But the individual of limited clinical experience is very likely to misuse this test, very likely to base his diagnosis upon an initial or a single high reading, without regard to the other factors in the case or the environment in which the test was taken.

It is important, also, to disentangle the purely cardiac and purely neurologic patient from the supposed toxic thyroid patient. That the thyrocardiac, as such, actually exists we would be the last to deny. There is general approval of Lahey's stand that operation is indicated in this type of case, even in poor surgical risks; stage surgery has brought salvation to many such patients. But we have also seen purely cardiac conditions regarded as of thyroid origin; a lucky chance prevented the personal performance of thyroidectomy upon one such patient who had been treated medically for her supposed toxic thyroid disease over a long period of time, and the recollection of that case averted a similar error in another. Neurasthenic patients, again, have been submitted to stage thyroidectomy, without benefit, of course, and frequently with actual harm. Finally, the differentiation between toxic thyroid disease and early tuberculosis, obvious though it may seem, may be exceedingly difficult.

The supposed toxic thyroid patient who is prepared within a week and discharged within another after lobectomy, returning within a month or two for a repetition of the performance, can scarcely be regarded as a candidate for stage surgery. No truly toxic patient could be properly prepared within so brief a period, aside from the fact that the use of Lugol's solution would be entirely ineffective within it. It is in these and similar patients that we contend that stage thyroidectomy is resorted to without justification. Multiple surgery is done without indication or warrant when it is done for toxic thyroid disease which is only mildly

toxic or not toxic at all. Its use under such circumstances proves nothing as to its value, and the economic rights of both patient and hospital are lost sight of in this trivial employment of a really valuable measure.

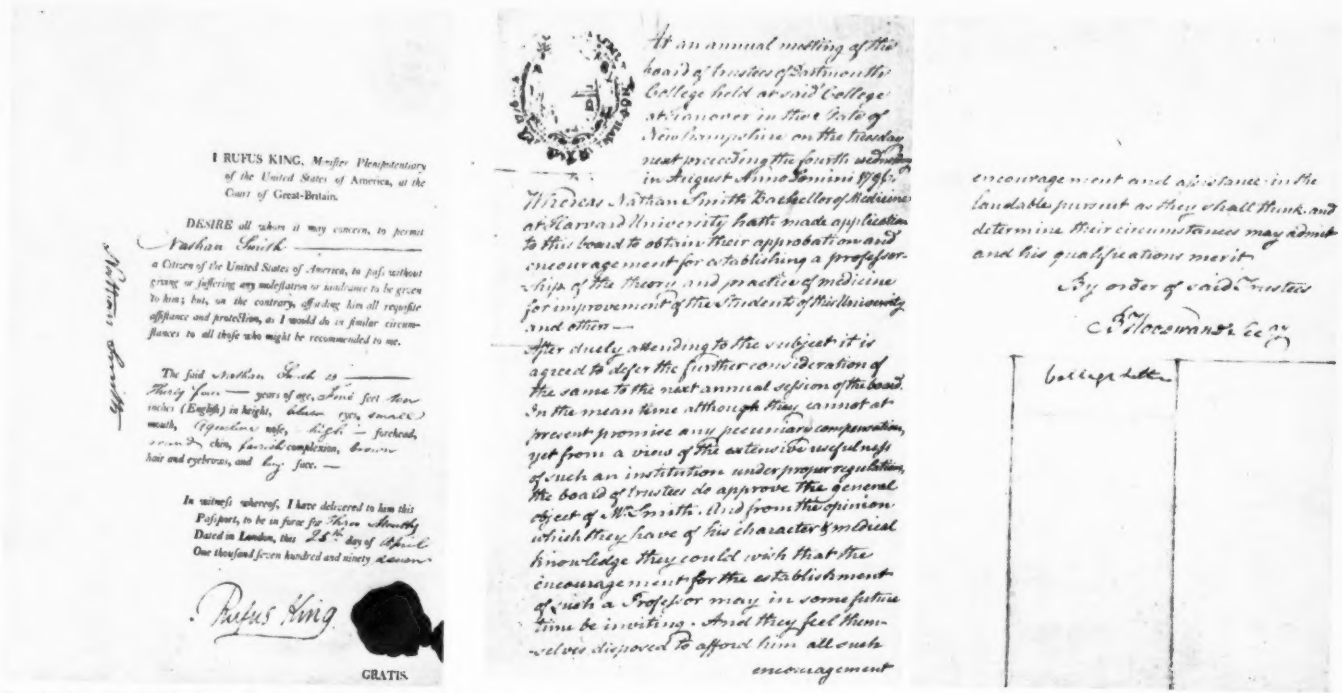
Whether the economic factor should enter into the treatment of disease may be, from the physician's standpoint, a debatable point, but from the patient's standpoint it is not. Very frequently from the patient's standpoint the whole problem is one of social economics. His financial status, the necessity of his earning his livelihood by the toil of his hands or his brain, the dozens of others who are watching his place in the industrial world and waiting to step into it, all these things must be thrown into the discard if his permanent restoration to health or if his actual life are in the balance. It is the duty of the physician, however, to be quite certain that they are actually in the balance. Stage surgery is time consuming and very expensive, and the surgeon has no moral right to advise it on trivial indications or merely to prove some thesis of his own.

The considerations are equally valid when the patient is a public charge. All institutions, whether endowed or government-supported, are today operating under grave financial difficulties and usually are called upon to meet needs far beyond their facilities to supply. From their standpoint stage surgery means double expense, and all too frequently means that what is given to one must be taken from another. When the expenditure of bed space and money is indicated, when it means, as it sometimes does, the difference between danger and safety, or even between life and death, there can be no question that the expenditure is urgent and necessary. But here, as in the case of the private patient, the necessity should be clearcut. That toxic disease does exist, that its manifestations are frequently exceedingly severe and even potentially lethal, that under such circumstances stage surgery is justified and lifesaving, we have no intention of denying. Our only point is that before it is resorted to, the necessity should be evident and the premises sound.

URBAN MAES.

PERITONEOSCOPY—A Correction

In the November, 1937 issue, of SURGERY, GYNECOLOGY AND OBSTETRICS, appears an article entitled "Peritoneoscopy" by Dr. John C. Ruddock. In "Table II—Accidents and Complications," which appears on page 635, under the subhead "Deaths," the percentage should read "0.2."



I RUFUS KING, Minister Plenipotentiary of the United States of America, at the Court of Great-Britain,

DESIRE all whom it may concern, to permit Nathan Smith

a Citizen of the United States of America, to pass without giving or suffering any molestation or hindrance to be given to him; but, on the contrary, affording him all requisite assistance and protection, as I would do in similar circumstances to all those who might be recommended to me.

The said Nathan Smith is Thirty four years of age, five feet four inches (English) in height, [illegible] eyes, small mouth, [illegible] nose, [illegible] forehead, round chin, [illegible] complexion, brown hair and eyebrows, and long face.

In witness whereof, I have delivered to him this Passport, to be in force for Three Months. Dated in London, this 25th day of April One thousand seven hundred and ninety seven.

Rufus King

GRATIS.

At an annual meeting of the board of trustees of Dartmouth College held at said College at Hanover in the State of New Hampshire on the Tuesday next preceding the fourth Wednesday in August Anno Domini 1796.

Whereas Nathan Smith Bachellor of Medicine at Harvard University hath made application to this board to obtain their approbation and encouragement for establishing a professorship of the theory and practice of medicine for improvement of the Students of this University and others —

after duely attending to the subject it is agreed to defer the further consideration of the same to the next annual session of the board. In the mean time although they cannot at present promise any pecuniary compensation, yet from a view of the extensive usefulness of such an institution under proper regulation, the board of trustees do approve the general object of Mr Smith's and from the opinion which they have of his character & medical knowledge they could wish that the encouragement for the establishment of such a Professor may in some future time be inviting. And they feel themselves disposed to afford him all suitable encouragement and assistance in the laudable pursuit as they shall think and determine their circumstances may admit and his qualifications merit.

By order of said Trustees

C. Marsh

College Letter

Facsimiles, reduced in size, of passport (left) issued April 25, 1797, to Nathan Smith, and letter from trustees of Dartmouth College, written in August, 1796, regarding the establishing of a professorship of theory and practice of Medicine at Dartmouth.

EARLY AMERICAN MEDICAL SCHOOLS

DARTMOUTH MEDICAL SCHOOL

COLIN C. STEWART, Ph.D., Hanover, New Hampshire

DARTMOUTH MEDICAL SCHOOL was founded in 1797 by Dr. Nathan Smith. Nathan Smith was born in 1762 at Rehoboth in Massachusetts but in his early boyhood the family settled in Chester, Vermont, across the Connecticut river from Charlestown, New Hampshire, Old Fort No. 4 until then because of the French and Indian Wars about the northern limit of safe settlement. The upper part of the Connecticut was shortly thrown open for colonization, and settlers from Connecticut and Massachusetts were eager to avail themselves of the new opportunities. In fact, in 1769 one reason assigned for the selection of the present site for Dartmouth College was that it was the natural center of "more than two hundred towns, chartered, settled, or about to be settled."

Nathan Smith was an officer in the Vermont Militia at the close of the Revolution, and in 1783 he was teaching a district school in Chester where he had an opportunity to witness and assist in an amputation done by Dr. Goodhue of Putney, Vermont. Smith applied for permission to study medicine under Dr. Goodhue and was advised by him to spend a year in preparation, which he did, studying under the Rev. Mr. Whiting of Rockingham, Vermont. From 1784 to 1787 Dr. Goodhue was his preceptor and in 1787 he began practice in Cornish, New Hampshire, where he remained for some years, except for the time spent at Harvard Medical School where he received the degree of M.B. in 1790.

The whole of the valley by that time was occupied by settlers to a degree that seems unbelievable at the present time, but a thorough study of any section of the region shows by its overgrown fields and pastures, by its stone walls and abandoned roads, its cellar holes and traces of orchards and gardens, that the country was covered by a close network of roads, dotted at regular intervals with dwellings, few remnants of which survive. The dwellers were undoubtedly poor in currency, but none the less well-to-do, for the presence near by of blacksmith shops and small mills made each community largely self sufficient. Transportation, judged by present standards, was difficult and slow, but it is well to remember that narrow hillside roads long since abandoned and overgrown were as good as any for horseback travel. The main arteries of travel were the turnpikes upon which there were regular stagecoach routes with transportation for both freight and passengers. Even for journeys of considerable length no special hardship was apparent for there were many wayside inns where a change of horses could be made.

One reads of various explanations for the abandonment of these homesteads, of the influence of the growth of factory towns, of the coming of the railroads, of the opening of the West to settlement, and of the possible impoverishment of the soil. Undoubtedly a still more potent factor was a change in the means of transportation. Roads that were good for riding were difficult or impossible for wheeled vehicles, and little by little the more inaccessible regions were to be given up. The process is still going on with the replacement of horsedrawn vehicles by automobiles. Even the turnpikes are in many cases now well nigh impassable.

For these widespread and growing communities in Nathan Smith's time there was a scant supply of medical assistance. Travel was easy but time-consuming. With very few established medical schools in the United States, the preceptorial system was the recognized method of preparing for practice. In Cornish, Smith's success as physician and surgeon was so outstanding that except in the case of Lyman Spalding, it seems to have been physically impossible for him to give adequate instruction to the many applicants for his aid. And yet he was acutely aware of the needs of the now thickly settled Connecticut Valley in the region from Cornish north as far as the Ammonoosuc River. For these reasons he made application to the trustees of Dartmouth College for approval of a plan to establish a professorship of the theory and practice of medicine. Their action in August, 1796, while withholding actual support gave him such encouragement that in December of that year he sailed for Scotland where he studied at Glasgow and Edinburgh, later going to London, sending

back books and anatomical and chemical apparatus which were to be used on his return in 1797.

The formal action of the trustees establishing the professorship is dated 1798, but the first course of lectures was begun November, 1797, as is witnessed by letters and by his daybook entries for that year. Two men were graduated in 1798. The first lectures were given in a building known as the Medical House, formerly standing to the west of the present building, since removed to the southwestern part of the town and still recognizable as part of a dwelling house. Later, lectures were given in rooms in Old Dartmouth Hall, but finally in 1810–11 the present "Medical Building," the oldest of the existing College group, was erected according to Dr. Smith's plans, partly by a small grant from the state, but largely at his own expense and on land deeded by him for the purpose. There have been many alterations in the original building, notably in 1871–73 when the Stoughton museum was provided for, and later by the addition of a wing for the anatomical laboratory.

In 1908 the Nathan Smith laboratory was built to accommodate pathology, histology, bacteriology, and pharmacology. Courses in embryology and biological chemistry are given in the laboratories of the College. Clinical courses are held for the most part in the Mary Hitchcock Memorial Hospital which was built by Mr. Hiram Hitchcock in 1891–93, in response to the efforts and needs of the members of the medical faculty.

In the beginning Nathan Smith gave all the lectures and his popularity is attested by large attendance. The lectures in chemistry were soon turned over to Rufus Graves and later to Lyman Spalding (founder of the U. S. Pharmacopœia). Doubtless this course, one of the earliest of its kind, attracted some of the students of Dartmouth College who registered for the medical lectures.

In 1813, discouraged by the state of affairs that culminated in the famous Dartmouth College case, Dr. Smith considered and accepted an invitation to be one of the group that gave the first courses at Yale Medical School. (He was also concerned in the founding of Bowdoin Medical College, 1821.) Nathan Smith returned to Hanover to lecture as late as 1816 but his remaining years were passed in New Haven where in 1829 he died.

The more inaccessible regions are now deserted except during the summer months. The distribution of the population has changed since Nathan Smith recognized the needs of the northern Connecticut Valley, and the nature of the need has changed, but the region still needs the stimulus and the support of a medical center in order that the earnest practitioners of the countryside may give their best to the people dependent upon them.

As was said in the presentation of the College case before the Supreme Court in 1818, Dartmouth "is only a small college but there are those who love it." The same can be said of the medical school.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE second, revised and reset, edition[1] of *The Diseases of Infants and Children*, by Griffith and Mitchell, an old standby in pediatrics, is in many ways a surprising piece of work. Its greatest value lies perhaps in the fact that in one volume so complete a pediatric practice can be included. It is well indexed and the bibliographies at the end of each chapter are remarkably up to date.

It cannot be said to be a new work because it contains much in the text which is of greatest interest from a historical point of view, for instance, the material on infant feeding; moreover, certain phases of pediatrics which are quite live subjects today are scarcely mentioned, notably erythroblastosis fetalis. Perhaps this is not too serious a criticism in view of the purpose for which this book was designed; it is a typical text and no text on a subject like pediatrics can be maintained up to date, for in a year or two what is now known about these controversial conditions might be quite antiquated.

The great value of this book lies in the sound common sense viewpoint taken by the authors, who speak from a background of vast experience and whose judgment, in so far as treatment is concerned, is the sort one would like to have used in his own family. Throughout the text are italicized sentences and paragraphs emphasizing the important points in the book.

This edition keeps a valued text as nearly up to date as is possible to keep such a work.

C. A. ALDRICH.

THE study of diet in relation to cancer is comprehensibly discussed by Hoffman in his recent book[2], *Cancer and Diet*. The book is based on 20 years of research and a study of 2,234 questionnaires from living cancer patients and 1,149 noncancerous controls. An extended review of cancer literature is included. The work is divided into four separate sections.

The first section is a historical review of the literature from 1777 to the present time. The second section deals with statistical facts relative to food consumption and the changes which have occurred during recent times. The purpose of this section is to illustrate the transition from the use of natural food products to modified food products, and to point to the introduction in this transition of many dangerous dietary factors.

Section three is a very thorough discussion of the metabolism in cancer as affected by organic and inorganic food compounds. Here we find many conflicting expert opinions, and this section is a veritable chaos.

The fourth section is a tabulation of general facts concerning cancerous patients and non-cancerous patients as obtained from the questionnaires mentioned, and the author's conclusion is derived from them.

There is a 64 page appendix which is an extensive tabulation and summary. In its entirety the book is a valuable accumulation of interesting data and is recommended not only to those interested in cancer as related to diet, but also to those interested in metabolic studies and endocrinology.

L. M. ROSENTHAL.

IN this monograph[3] of 214 pages, Putti presents a complete review of the lumbar-sacral-sciatic syndrome based upon a study of 1,121 cases. It is a compilation of what the author has presented in various papers and lectures with the addition of his more recent studies on the subject.

Three pages are devoted to the cervical-thoracic-brachial neuritis syndrome, and its similarity to the lumbar-sacral-sciatic syndrome is emphasized. The subject is presented in a well planned manner, beginning with the neuro-osseous anatomy of the lumbar sacral region. Then the etiology of pain in sacralization of the fifth lumbar is presented with roentgenograms and line drawings made from the films.

The author offers several short case histories and comments thereon. Before presenting his theories of tropism he gives a good anatomical description of the lumbar vertebræ. Roentgenograms, diagrams, and photomicrographs are interwoven in order to elucidate the variations of the planes of articulations of the facets.

Congenital anomalies and arthritis are discussed. Several chapters are devoted to arthritis of the articular facets and four colored drawings supplement the text. The pen and ink drawings, made from films, complete the picture.

The entire subject is clearly and adequately presented in a manner that reveals the author's profound knowledge and ability as a teacher.

In succeeding chapters the problem of lumbar sacral disability associated with radiculitis and sciatica, is considered. Here the examination of the patient is supplemented by photograms revealing the point of buttock pain in relation to sciatic scoliosis.

[1] THE DISEASES OF INFANTS AND CHILDREN. By J. P. Crozer Griffith, M.D., Ph.D., and A. Graeme Mitchell, M.D. 2d rev. ed. Philadelphia and London: W. B. Saunders Co., 1937.

[2] CANCER AND DIET; WITH FACTS AND OBSERVATIONS ON RELATED SUBJECTS. By Frederick L. Hoffman, LL.D. Baltimore: The Williams & Wilkins Co., 1937.

[3] LOMBOARTRITE E SCIATICA VERTEBRALE; SAGGIO CLINICO. By V. Putti. Bologna: L. Cappelli, 1936.

The symptoms of muscle spasm in scoliosis with descriptive line drawings, photographs and roentgenograms, are given. Camptocormia and alternating scoliosis are clearly described. There are some excellent descriptions of the postural attitudes assumed to relieve pain. Diagrams of the distribution of the second, third, and fourth and fifth lumbar and first and second sacral nerves, aid in understanding the localization of the pathological changes in the lumbar or sacral areas. This is supplemented by roentgenograms and photographs of the patients.

The discussion of nerve involvement includes the sensory, motor, and reflex disturbances, trophic changes, and sympathetic nerve involvement. All the neurological findings are correlated with the clinical examination and roentgenograms.

A chapter on diagnosis includes a differential of meningitic muscle spasm with scoliosis and ankylosing spondylitis, early Pott's disease, syphilis, neoplasms of vertebral or spinal cord origin, disturbances due to sacro-iliac and hip joint pathology, intervertebral disc pathology, peripheral nerve lesions, and sciatic neuritis.

Fifty pages are devoted to treatment, which includes a discussion of the methods of selection of proper therapy for the individual patient. It covers physical therapy, immobilization by casts, corsets, and braces. A detailed description of the author's method of making removable plaster jackets and the hot-air treatment, is worthy of careful attention.

Surgical treatment considers in detail the indications, technique, and case reports of lamino-arthrectomy, arthrodesis, facetectomy, transversectomy, and menisectomy for protrusion of the intervertebral disc.

The monograph is excellently and adequately supplied with 114 instructive photographs, diagrams, and roentgen reproductions. There are 5 colored drawings of operative exposures which are excellent. The literature is freely quoted and a complete bibliography appears in footnotes. The monograph closes with 8 pages on injuries of the lumbar spine associated with sciatica. PHILIP LEWIN.

A WEALTH of information is contained in the authoritative volume[1] on thyroid gland disease by Means. The book represents the experience of a careful student, a medical man, not a surgeon, who has had the advantages of charity facilities for prolonged medical observation, active physiological and clinical research, and good surgical co-operation —a combination of advantages rarely found. The Thyroid Clinic of the Massachusetts General Hospital represents these factors. The literary style is worthy of mention; it is simple, readable, and refreshing. Specific problems are usually attacked with reference to scientific data accumulated by the author's own research. Throughout the book, charts and diagrams present a very extensive material on thyroid physiology and disease.

It will be a pleasure and an education to use this volume for study and reference. PAUL STARR.

A HIGHLY commendable plan is used by Shands in his *Handbook of Orthopædic Surgery*[2] in discussing general joint phenomena, the causes of pathological changes in bones and joints, and physical diagnosis in the orthopedic patient. Congenital deformities, affections of growing bone, affections of adult bone, infections of joints, and chronic arthritis, are discussed. The author has stressed the importance of physiological and anatomical considerations in determining the diagnosis and treatment.

The book is divided into 24 chapters: 16 chapters discuss the pathological lesions of orthopedic surgery; 7, the lesions of various regions of the body; and 1 chapter, body mechanics and physical therapy.

The book is well planned, is easy to read and understand, and is a safe one for students. Brevity, which is one of its chief virtues, is at times too great. Fundamental facts and principles are given very concisely. Controversial points are not discussed but the book represents the consensus of the present-day teachers of orthopedic surgery.

The illustrations, well selected and well spaced, are chiefly line drawings and diagrams and are most instructive. The illustrations of bursæ are very effective.

This *Handbook of Orthopædic Surgery* is a valuable book for the student and the practitioner of orthopedic surgery. If for no other reason than its extensive and excellent bibliography, it would be well worth its cost. PHILIP LEWIN.

THERE is no doubt that Bick has done a tremendous amount of collateral reading in order to place before the profession, in so concise a form, so much valuable information—both from the historical and the practical points of view—as is contained in his *Source Book of Orthopædics*.[3]

The subject matter is discussed under the headings: primitive man and ancient practices, middle ages, renaissance, 17th century, 18th century, and the modern period. Bick discusses physiology, pathology, and methods of practice of bone-joint and muscle-tendon surgery. His descriptions of non-operative orthopedics and the rise of orthopedic hospitals and institutions are very interesting and instructive.

The manuscript reads like a story book. The bibliography is invaluable. Every physician should have the book in his library and, when he wants an hour or two of intensely interesting and authoritative reading, this is one book that will not fail him.

There has been nothing that compares with this book since the classical *Menders of the Maimed* by Sir Arthur Keith. PHILIP LEWIN.

[1] THE THYROID; AND ITS DISEASES. By J. H. Means, M.D. Philadelphia, Montreal, London: J. B. Lippincott Co., 1937.

[2] HANDBOOK OF ORTHOPÆDIC SURGERY. By Alfred Rives Shands, Jr., B.A., M.D. In collaboration with Richard Beverly Raney, B.A., M.D. St. Louis: The C. V. Mosby Co., 1937.

[3] SOURCE BOOK OF ORTHOPÆDICS. By Edgar M. Bick, M.A., M.D. Baltimore: The Williams & Wilkins Co., 1937.

IN the symposium[1] on the relationship of trauma to disease, edited by Brahdy, the authors stress the fact that their discussions deal particularly with the effect of a single trauma, either physical or psychic, in evoking, precipitating, or aggravating disease. The book, which should be read with great interest by medical men who devote any part of their time to industrial casualty work, comes at a time when there is a distinct need for such a volume which will serve as a reference book giving the prevalent opinions as to the relationship between trauma and certain pathological conditions. The book should prove indispensable to men who appear before industrial boards or act as medicolegal advisors to the carriers of casualty insurance.

A wide variety of medical and surgical subjects is covered; the list of contributors is very imposing and is made up of outstanding men in their special fields. There are no illustrations in the book. It would be unfair to single out any chapter as being unusually well presented, but the reviewer found the chapter on "Trauma and Diseases of the Spine" unusually illuminating and the chapter on "Trauma and Neoplasms" to contain a wealth of valuable information.

The authors should be proud of this book. One feels confident that the many references which will be made to its contents will be very flattering to the contributors.

R. W. McNEALY.

THE recent book[2] by Tchaperoff presents an excellent synopsis of the details of radiological diagnosis. The author lays great stress on a systematic study of the roentgenographic and roentgenoscopic findings, which must be analyzed carefully, step by step. Details are liable to be overlooked unless such a study is undertaken. The author seeks to inculcate and to illustrate by numerous examples, first from a general and then from a regional point of view, how to make a systematic study of the roentgenologic findings in the principal, as well as some of the rarer, diseases.

The arrangement of the work facilitates the making of a differential diagnosis. The illustrations are generous, some perhaps a little larger than need be; but with practically all of them, one can only express agreement and approval. The reviewer considers this an excellent type of textbook in radiological diagnosis and yet it contains enough information to be a valuable book for the desk of any diagnostician.

JAMES T. CASE.

THE relationship of blood pressure to protein intake in the diet is discussed by Harris in *High Blood Pressure.*[3] The book gives the results of a tremendous number of laboratory studies made upon various constituents of the blood and urine of patients receiving high and low protein diets. The results of these determinations are given in great detail, but few records are given concerning the clinical findings of the patients under study. Dr. Harris revives the more or less discarded concept that hypertension is definitely related to high protein intake in the diet. He goes so far as to predict that as soon as the public regulates its mode of living to only necessary dietary requirements, the incidence of "hypertony" will be materially reduced. The text makes little mention of other investigators' work in this field and there is a limited bibliography. The author's concept of hypertension is not in accord with the consensus of most modern writers on this subject. The book will be of interest only to those who wish to consider the studies of the author concerning the relationship of hypertension to protein intake in the diet.

CHAUNCEY C. MAHER.

THE first portion of Plesch's *Physiology and Pathology of the Heart and Blood Vessels*[4] is devoted to a discussion of mathematical details of the physics of the circulation. The second portion of the book is concerned with cardiac insufficiency with relatively little correlation with the physics which the author previously discussed. Belying its title the book contains only minor paragraphs and illustrations of the pathology of the heart and blood vessels. There is practically no bibliography and the index is only fair. The book is well printed but cheaply bound. There is little to be said in recommendation of this text.

CHAUNCEY C. MAHER.

TWENTY-FIVE years ago Sir St. Clair Thomson first published a text based on his own clinical experience and observation in diseases of the nose and throat. It proved so popular and successful that it is now in its fourth greatly enlarged edition.[5] V. E. Negus has contributed the section on diseases of the air and food passages. The book is rather complete, containing 1,000 pages with 400 illustrations and radiographic plates.

Basically the general scheme of the original text has been maintained, effort being made to treat the subject matter scientifically but at the same time to retain its readability and simplicity. The chapters on malignancy of the larynx are especially well written, while that on tuberculosis of the air passages written from the author's personal experience appears to cover the subject rather thoroughly.

Undoubtedly this latest edition will prove to be as useful as a text and reference work as the previous editions.

JOHN F. DELPH.

[1] TRAUMA AND DISEASE. Edited by Leopold Brahdy, B.S., M.D., and Samuel Kahn, B.S., M.D. Philadelphia: Lea & Febiger, 1937.

[2] A MANUAL OF RADIOLOGICAL DIAGNOSIS; FOR STUDENTS AND GENERAL PRACTITIONERS. By Ivan C. C. Tchaperoff, M.A., M.D., D.M.R.E. (Camb.). With a foreword by Philip H. Mitchiner, M.D., M.S., F.R.C.S. Baltimore: William Wood & Co., 1937.

[3] OXFORD MEDICAL PUBLICATIONS. HIGH BLOOD PRESSURE. By I. Harris, M.D. London: Oxford University Press, 1937.

[4] OXFORD MEDICAL PUBLICATIONS. PHYSIOLOGY AND PATHOLOGY OF THE HEART AND BLOOD-VESSELS. By John Plesch, M.D. (Budapest), M.D. (Germany), L.R.C.P. London: Oxford University Press, 1937.

[5] DISEASES OF THE NOSE AND THROAT; A TEXTBOOK FOR STUDENTS AND PRACTITIONERS. By Sir St. Clair Thomson, M.D., F.R.C.P. (Lond.), F.R.C.S. (Eng.), LL.D. (Hon.) Winnipeg, Médecin diplomé en Suisse, and V. E. Negus, M.S. (Lond.), F.R.C.S. (Eng.). 4th ed. New York and London: D. Appleton-Century Co. Inc., 1937.

THE three volume text *Surgical Treatment*[1] by Warbasse and Smyth covers the entire field of surgery, which should be welcomed by the general physician as well as the surgeon, especially because the subject matter has been brought up to date. This is perhaps best demonstrated by a most interesting chapter on anesthesia, in which many of the new agents are given consideration, a well worth while discussion on the injection treatment of hernia, as well as chapters on the use of heat, light, electricity, x-ray, and radium in surgical treatment. Each volume is profusely illustrated. The volumes may be best described in the words of the authors when they state that they have endeavored to present the maximum of treatment.

Whereas in most works of this type, one or possibly two methods of treatment are brought forth, Warbasse and Smyth have gone beyond the more or less accepted trend, and offer a variety of therapeutic measures. As an example of the varieties given, the treatment for hydrocele of the cord may be used, wherein the authors offer eight different forms of treatment. Each operation is gone into with considerable detail, aided considerably by numerous illustrations. Throughout the 3 volumes the non-operative as well as the operative treatment is stressed, the virtues as well as the handicaps of each form of treatment being emphasized. Much valuable information is contained in these volumes which should be a welcome addition to every medical man's library, be he interested in medicine, surgery, gynecology, nose and throat, or other specialized fields.

The authors have left the beaten path by concluding their work with a chapter on the economic and social aspects of surgical treatment, in which (1) competitive practice; (2) state socialization; (3) group practice; (4) organization of patients; (5) consumers' co-operative organization; and (6) control of group practice are stressed. These are vital problems to the medical profession and again illustrate the modern trend of this work.

EARLE I. GREENE.

IN his first book[2] in the English language devoted to the subject, Dr. Rudolf Schindler presents a comprehensive study of gastroscopy. After a thorough discussion of the history of gastroscopy, the anatomy of the stomach and the problems of gastroscopic construction and technique, attention is directed to the clinical applications of this procedure. Gastroscopic orientation is carefully explained and illustrated by numerous diagrams. The description of the normal stomach and its movements during the examination should prove valuable to medical students and practitioners alike. Of practical interest is an outline of the indications for gastroscopy. The chapter on circulatory disturbances of the stomach contains much new information of direct clinical significance.

Chronic gastroduodenal ulcer and gastritis comprise the two clinically important sections of this work. An excellent analysis of the controversial opinions related to these subjects is presented, and the author's conclusions are most clarifying. Evidence is also brought forth in criticism of the gastritic origin of ulcer. Gastroscopic studies are recorded on the progress of gastric ulcers and on the development of chronic ulcers from mucosal hemorrhages. The author has re-awakened interest in the problems of gastritis and has particularly indicated the frequency with which it occurs. The opinions of Knud Faber, Simpson, Kalk, and Moutier receive critical appraisal. Schindler's classification, which has been accepted by most workers, is based upon a correlation of gastroscopic findings with the course of the disease. His discussion of superficial, atrophic and hypertrophic gastritis is very thorough and includes the histology, etiology, clinical course, and therapy of each condition as well as the gastroscopic findings. The relationship between chronic hypertrophic gastritis and gastric ulcer is very carefully evaluated.

The subject of malignant tumors is equally well covered. The advantages of gastroscopy in the early diagnosis of malignancy and in the differential diagnosis between benign and malignant ulcer are made obvious. The postoperative stomach, first described by Schindler in 1922, has assumed greater significance with the increasing incidence of gastric surgery. Important and generally new observations of the gastro-enterostomy stoma, recurrent gastric and gastrojejunal ulcer are recorded. Gastritis of the postoperative stomach is classified as a distinct entity, and is considered to be the most severe form of gastritis. The subjects of foreign bodies and variations in the shape of the stomach are commented upon briefly. The work is concluded with remarks on the relationship of gastroscopy to surgery, gastrophotography, roentgen-ray examination, and with a discussion on the different laboratory methods.

This book offers an excellent discussion of gastroscopy and its clinical applications. The author has taken great care in his exposition of the gastroscopic findings in the normal stomach. The chapters on chronic gastroduodenal ulcer and gastritis merit special recommendation for their completeness and their analyses of conflicting opinions. One is impressed by the many illuminating concepts of gastric disease which are presented; 89 text figures and 96 color reproductions beautifully illustrate the various gastroscopic findings. Only one who has seen the gastric mucosa through the gastroscope can appreciate the accuracy of these pictures. The bibliography is very complete.

This book can be highly recommended as an authoritative endoscopic study of gastric pathological conditions.

JOSEPH B. KIRSNER.

[1] SURGICAL TREATMENT; A PRACTICAL TREATISE ON THE THERAPY OF SURGICAL DISEASES. By James Peter Warbasse, M.D., F.A.C.S., and Calvin Mason Smyth, Jr., B.S., M.D., F.A.C.S. 2d rev. ed. Vols. 1, 2, 3, and index. Philadelphia and London: W. B. Saunders Co., 1937.

[2] GASTROSCOPY; THE ENDOSCOPIC STUDY OF GASTRIC PATHOLOGY. By Dr. Rudolf Schindler. With a preface by Dr. Walter Lincoln Palmer. Chicago: The University of Chicago Press, 1937.

IN a small volume[1] of 207 pages Davidoff and Dyke have discussed, even if they have not solved, the many problems of encephalography which everyone must meet who has occasion to use this valuable diagnostic procedure. In logical order the subjects of technique, the ventricular system, the cerebral convolutions and sulci, the subarachnoid cisterns, and the various cerebral and cerebellar structures are discussed in their relation to the interpretation of the x-ray pictures taken after the lumbar subarachnoid injection of gas. The purpose has not been to offer pathologic material for object lessons; rather, it is their aim to delineate by text and many well chosen photographs the normal intracranial anatomy in the presence of ventricular and subarachnoid gas, and especially to aid in the recognition of the air-filled spaces themselves as their appearance varies in different individuals and in different positions of the x-ray.

A brief but adequate review of various current methods of performing encephalography is given, and it is gratifying to learn that the authors use a simple, direct, uncomplicated technique which should suffice for anyone else humble enough to discard the complicated in favor of the simple. The one-needle method with syringe is used, fluid being allowed to run out in small amounts to be replaced by a slightly smaller amount of gas (air or oxygen), with the simultaneous taking of x-ray pictures to aid in determining when an adequate amount of gas has been injected. All encephalographies are done in the x-ray department. The problem of why the ventricles do not always fill puzzles the authors as it does many others, and though they set forth several logical arguments in explanation, it seems apparent that the matter still remains unsolved even with them.

A disproportionate amount of effort has been expended on the discussion of the surface anatomy of the brain if the intent is to offer diagnostic assistance; anatomically, however, it is interesting, and many of the illustrations are excellent. No doubt the authors are convinced that they are able to see all that they label in their figures of the various finer structures in the cranium, knowing that the structures *are there*, but Figure 133 taxes the credulity of the reviewer in his effort to visualize a pontine branch of the basilar artery, and visualization of the oculomotor nerve in Figure 104, together with several other examples of identification, indicates ambition to the point of overinterpretation by the authors. The description of the foramen of Munro is perplexing, and it is not entirely within keeping in the light of actual dissection or direct casting of the ventricular spaces.

The Normal Encephalogram is a well written book, compact, straightforward, instructive in intracranial anatomy; it is an assurance of the value of encephalography, and it should be of much value to anyone confronted with some of the more difficult problems of neurological diagnosis. It is based on an experience of 4,000 cases, as well as on a comprehensive review of the literature, and it may safely be considered authoritative. JOHN MARTIN.

[1] THE NORMAL ENCEPHALOGRAM. By Leo M. Davidoff, M.D., and Cornelius G. Dyke, M.D. Philadelphia: Lea & Febiger, 1937.

THE author, James E. Gibson, has done an enormous amount of research work in the preparation of *Dr. Bodo Otto and the Medical Background of the American Revolution*[2]. The book begins with an exposition of the facts unearthed from old records in Germany, on births, deaths, and marriages, in which various members of the family of Dr. Otto are mentioned. Upon these scanty facts certain suppositions are based. This part of the book, covering 42 pages, ends with the emigration to and the adjustment of Dr. Bodo Otto to life in Pennsylvania and New Jersey. He became a surgeon in the medical department of the Continental Army, as did his son. Both rendered valuable if undistinguished service.

The next 283 pages deal with the organization or lack of organization of the medical services of the Continental Army; the difficulties experienced by Washington; the squabbles and cabals involving Rush, Shippen, and Church; the inadequacy of medical supplies; the appalling death rate from disease among the Continental soldiers, and the activities of committees of the Continental Congress. Dr. Bodo Otto's rôle during these trying times was that of a conscientious doctor concerned, as were dozens of others, only with the care of the sick. His name is not mentioned for dozens of pages. This part of the book abounds in quotations from documents, letters and newspapers of the time, and forms a valuable reference source for those interested in the medical history of the Revolutionary period. Unfortunately, there is no bibliography.

Having read the book with a good deal of curiosity as to Dr. Bodo Otto, with whose name I was previously unacquainted, I must honestly say that I can see no good reason for placing his name on the title page of a book dealing with such stirring times.
W. H. HOLMES.

A BOOK in English on roentgenology of the heart and cardiovascular system has long been awaited. Roesler's equipment for the preparation of such a work is attested by his responsible position in Temple University School of Medicine and Hospital. This welcome addition[3] to roentgenological literature presents an adequate discussion of the technical and clinical bases for the x-ray examination of the cardiovascular system. Various methods of measurement are evaluated. Comparisons are made between the anatomical, clinical, and roentgenological findings in relation to the heart; and the roentgenological aspects of the various diseases

[2] DR. BODO OTTO; AND THE MEDICAL BACKGROUND OF THE AMERICAN REVOLUTION. By James E. Gibson. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

[3] CLINICAL ROENTGENOLOGY OF THE CARDIOVASCULAR SYSTEM; ANATOMY, PHYSIOLOGY, PATHOLOGY, EXPERIMENTS AND CLINICAL APPLICATION. By Hugo Roesler, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

which concern the heart are classified and discussed at such length that the text requires more than 300 pages. Almost without exception the numerous illustrations are well reproduced. Kymography is discussed at some length and there are sections on vasography, arteriography, venography, and lymphography. Altogether it is a well written and beautifully reproduced book and should interest everyone concerned in the study of the human heart.

JAMES T. CASE.

AS stated in the preface by the author *Heart Failure*[1] is intended primarily for the practitioner. It would increase the knowledge of heart failure enormously and would improve the care of cardiac patients considerably, if all general practitioners did read and study this new important addition to our medical literature.

The book is essentially an exposition of the various features of heart disease, although some attention is given to the description and enumeration of the ordinary signs and symptoms of heart failure. When the author discusses the latter aspect of the subject incompletely, he refers the reader to appropriate articles for further study. The outstanding contribution of this volume is that it contains a complete exposition of the physiological and pathological mechanisms involved in the production of the various signs and symptoms of heart failure. With this are coupled clinical experiences that illustrate the points involved. We have had books of a theoretical and others of a purely clinical nature. This has attempted to combine both and has done so with unusual success. The subject of heart disease particularly lends itself to this close union, for theoretical knowledge of the dynamics of the circulation has increased tremendously during the past decade or so, and is indispensable for the understanding of the practical treatment of the cardiac patient.

The book contains thirty-seven chapters. The early ones are given over to a discussion of the individual and specific manifestations of heart failure, such as dyspnea, edema, cyanosis. These are followed by chapters on the types of heart disease producing the various forms of heart failure. Finally, the treatment of circulatory failure is considered There are numerous and well chosen references to original articles on subjects under discussion. One can therefore quickly survey the background of problems both clinical and experimental.

Although the book is called *Heart Failure*, and that is its main theme, it contains much useful knowledge concerning heart disease. Particularly impressing is the discussion of the nature and mechanism of paroxysmal dyspnea, periodic breathing, and orthopnea. The entire volume is a splendid addition to the recent publications that have come out in this country on the subject of heart disease. It ought to obtain the same enthusiastic reception on the part of the medical profession as Dr. Fishberg's earlier book *Hypertension and Nephritis*.

SAMUEL A. LEVINE.

IT has been a pleasure to survey the new edition of *The Operations of Surgery* by Rowlands and Turner.[2] Since the last edition which appeared in 1927 the medical profession has suffered a great loss in the death of R. P. Rowlands, the senior author. For the past two or three decades Rowlands has been one of the leaders in the field of English surgery, and his guiding hand will be much missed at Guy's Hospital, where he has so faithfully served humanity and the medical profession. It is of interest to note that this work is the direct descendant of the *Operations of Surgery* by W. H. A. Jacobson which was first published in 1889.

Before his death, Rowlands had revised the chapters on peritonitis, operations on the stomach and duodenum, visceroptosis and chronic constipation, and operations on the intestines. The chapters dealing with the preparation of the patient, operations on hernia, the spleen, pancreas, and rectum, and the vertebral column have been revised by W. H. Ogilvie. The chapters depicting operations on the lower extremity and the tendons have been rewritten by Grant Massie, and A. Ralph Thompson has revised the chapters on operations on the kidney and ureter, bladder, prostate, urethra, and penis. Portions of the work pertaining to gynecology were revised by G. F. Gibbord, and R. C. Brock has rewritten the section on thoracic surgery.

This work portrays English surgery in an accurate manner as we of the States conceive it; it displays conservatism as well as accuracy. The chief points of interest are a description of the indications as well as the contra-indications for the proposed operation, an accurate and clear description of the procedure, and a suggestion as to what possible complications may be anticipated. Surgical judgment is stressed as well as operative skill since "Technical skill by itself may even be dangerous without the guidance of adequate knowledge and sound judgment." The test is clear and the illustrations are many and strikingly instructive.

The impression is gained that pre-operative and postoperative care are not stressed as much in England as they are in America. The administration of water to maintain a proper water balance is very inadequately described and no definite regimen is given. In America this procedure, so well developed by Coller and his coworkers, forms much of the basis of proper pre-operative and postoperative care. The intravenous administration of dextrose solution and blood transfusion are rarely mentioned. For the treatment of biliary tract disease and to reduce the coagulation time of the blood to normal, the advice which is very briefly given is to administer calcium chloride intravenously as recommended by Walters

[1] HEART FAILURE. By Arthur M. Fishberg, M.D. Philadelphia: Lea & Febiger, 1937.

[2] THE OPERATIONS OF SURGERY. By R. P. Rowlands, M.S. (Lond.), F.R.C.S. (Eng.), and Philip Turner, B.Sc., M.S. (Lond.), F.R.C.S. (Eng.). 8th ed. Two volumes. Baltimore: William Wood & Co., 1937.

in 1922 along with "carbohydrates and water freely by mouth and glucose and water by rectum." It has been proved that glucose is not absorbed from the colon and many individuals cannot tolerate enough water per rectum so that they may absorb a sufficient amount to maintain a water balance. It has been fairly definitely demonstrated by physiologists that sugar, calcium, and vitamin D are the protective agents for a disabled liver and that every effort should be put forth in their administration to assure the availability of a sufficient quantity of these substances over a period of time.

This edition again demonstrates the difficulty in making revisions of extensive works. Much material must be and is carried over lest the revision entail a complete rewriting. Due to this many references are not of recent date. It is noted that the statistics for the results of suprapubic prostatectomy are quoted from Freyer, 1911–1913, and those for results of operations for gastric and duodenal ulcers at a somewhat later date but not what the reader would like to know, i.e., what are the results now?

It may be an advantage to the experienced surgeon to find occasionally disagreements from what he may think generally accepted principles. Allusion is made to statements in the discussion of the treatment of appendiceal abscess. Relative to a "leak into the peritoneum" incident to the removal of the appendix imbedded in the wall of the abscess which seems to be advocated, the author states: "There is only one certain way of preventing this catastrophe and this is by first deliberately opening the peritoneum internal to the abscess, and packing off carefully before the abscess is opened." This advice, I am confident, is contrary to the generally accepted teaching in America and since it emanates from an authority in abdominal surgery warrants study. Differences of opinion deserve wholesome thought and often lead to better solutions of problems.

This work depicts a conservative attitude although many of the radical and formidable operations are described. It is interesting to note that transurethral resection of the prostate is not mentioned. This procedure which has met with great favor in America is not being used very extensively in England. A midway position is likely to develop. This work retains the great merit which it has gained in the past and it is hoped that the new collaborators will continue their interest in its perpetuation.

JOHN A. WOLFER.

A SMALL book of 133 pages copiously illustrated with line drawings has been written by Spiers[1] and touches upon practically the entire field of fracture surgery. While the book is not encyclopedic in nature, important aspects are stressed, and the impression is gained that the book is intended to help students and internes rather than those whose knowledge of this field is more advanced. For this purpose, the book will serve as a valuable adjunct to the standard texts on the subject of fractures.

JAMES K. STACK.

IN taking one joint and covering it thoroughly as Dr. Albee has done from the vantage point of his immense surgical experience, this book[2] can be compared to Dr. Codman's work on *The Shoulder*, both being very valuable and full of useful information for an orthopedic or general surgeon. The book deals primarily with operative treatment to which the bulk of the script and illustrations is given, but this is founded on an excellent base of anatomy, physiology, and some pathology, together with very helpful and essential advice on technical details of equipment, etc. As usual he makes the procedures advised seem so clear and easy that there is a risk that the uninitiated surgeon may be tempted into the very real difficulties which have a way of cropping up in even the most routine of hip operations. The chapter on fractures is by far the best and presents the whole modern group of operative procedures clearly, though he definitely advocates his own bone grafting method. Dr. Albee has seen the whole development of hip joint surgery and has made such outstanding contributions to it himself that he speaks with just authority. When he comes to tuberculosis of the hip in its non-operative aspects, there is a distinct slackening of interest and a proper balance is lacking, which is also noticeable in several of the later chapters which bring the book to a rather abrupt end. All in all Dr. Albee has given that extremely valuable quality to the book, namely, that any reader can see clearly that what he says and advocates is his own honest conviction based on long and wide personal experience. It is to be hoped that its success will tempt others to deal in the same spirit with other joints or anatomical provinces.

ROBERT W. JOHNSON, JR.

[1] A BRIEF OUTLINE OF MODERN TREATMENT OF FRACTURES. By H. Waldo Spiers, A.B., M.D. Baltimore: William Wood & Co., 1937.
[2] INJURY AND DISEASES OF THE HIP; SURGERY AND CONSERVATIVE TREATMENT. By Fred H. Albee, M.D., LL.D., F.A.C.S. assisted by Robert L. Preston, M.D. New York: Paul B. Hoeber, Inc., 1937.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE DIARY OF A SURGEON IN THE YEAR 1751–1752. By John Knyveton. Edited and transcribed by Ernest Gray. New York and London: D. Appleton Century Co., 1937.

PHYSICAL THERAPY IN ARTHRITIS. By Frank Hammond Krusen, M.D. Foreword by Melvin S. Henderson, M.D. New York: Paul B. Hoeber, Inc., 1937.

CRIPPLED CHILDREN; THEIR TREATMENT AND ORTHOPEDIC NURSING. By Earl D. McBride, B.S., M.D., F.A.C.S. In collaboration with Winifred R. Sink, A.B., R.N. 2d ed. St. Louis: The C. V. Mosby Co., 1937.

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS. By John Albert Key, B.S., M.D., and H. Earle Conwell, M.D., F.A.C.S. 2d ed. St. Louis: The C. V. Mosby Co., 1937.

OXFORD MEDICAL PUBLICATIONS. RADIATION THERAPY; ITS USE IN THE TREATMENT OF BENIGN AND MALIGNANT CONDITIONS. By Ira I. Kaplan, B.Sc., M.D. New York: Oxford University Press, 1937.

TWENTY-FIVE YEARS OF HEALTH PROGRESS. By Louis I. Dublin, Ph.D., and Alfred J. Lotka, D.Sc. New York: Metropolitan Life Insurance Co., 1937.

ARTERIOVENOUS ANEURYSM; ABNORMAL COMMUNICATIONS BETWEEN THE ARTERIAL AND VENOUS CIRCULATIONS. By Emile Holman, A.B., B.A. (Oxon.), M.D. New York: The Macmillan Co., 1937.

THE COLLAPSE THERAPY OF PULMONARY TUBERCULOSIS. By John Alexander, B.S., M.A., M.D., F.A.C.S. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

A PRACTICAL TREATISE ON DISEASES OF THE SKIN; FOR THE USE OF STUDENTS AND PRACTITIONERS. By Oliver S. Ormsby, M.D. With revision of the Histopathology and Mycology by Clark Wylie Finnerud, B.S., M.D. 5th rev. ed. Philadelphia: Lea & Febiger, 1937.

APPENDICITIS; A CLINICAL STUDY. By W. H. Bowen, Hon. M.A. (Camb.), M.S. (Lond.), F.R.C.S. Cambridge: The University Press, 1937.

A CRITICISM OF NURSING EDUCATION; WITH SUGGESTIONS FOR CONSTRUCTIVE REFORM. By Harold Balme, M.D. (Durh.), F.R.C.S. (Eng.), D.P.H. (Lond.). London: Oxford University Press, 1937.

DISEASES OF THE BLOOD AND ATLAS OF HEMATOLOGY; WITH CLINICAL AND HEMATOLOGIC DESCRIPTIONS OF THE BLOOD DISEASE INCLUDING A SECTION ON TECHNIC AND TERMINOLOGY. By Roy R. Kracke, M.D., and Hortense Elton Garver, M.S. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1937.

PRACTICAL NEUROANATOMY; A TEXTBOOK AND GUIDE FOR THE STUDY OF THE FORM AND STRUCTURE OF THE NERVOUS SYSTEM. By J. H. Globus, B.S., M.D. Baltimore: William Wood & Co., 1937.

CHEMISTRY OF THE BRAIN. By Irvine H. Page, A.B. (Chem.), M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.

A MONOGRAPH ON VEINS. By Kenneth J. Franklin, D.M., M.R.C.P. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1937.